AFTER-TREATMENT



AFTER-TREATMENT

A guide to General - Practitioners, House - Officers, Ward-Sisters and Dressers in the care of patients after operation

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THIRD EDITION

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TO

MY FATHER

WHO HAS DEVOTED HIS LIFE TO THE CARE OF

HIS PATIENTS

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PREFACE TO THIRD EDITION

SINCE the last edition of this book was published two remarkable instruments of healing have come into our hands. The first of these is penicillin. Not only has it been necessary to include short sections on the parenteral and local uses of penicillin, but its benign influence is so permeating that there is hardly a chapter where its effect has not led to modifications in the text, while some sections have had to be completely rewritten. The virtues of this material have been well and justly publicised both in the medical and lay press, so that all must now be familiar with this magnificent achievement of British Medicine.

The other instrument comes to us from America. Its influence is less dramatic and it has never, so far as I know, occupied headlines in the daily press; but its benefits are immense and countless patients have owed their lives to it, while hundreds are daily relieved of suffering through its agency. It was only when I was preparing the text for this edition, and on page after page crossing out such expressions as, "if the vomiting persists", "the volume of the vomit is charted", "excessive vomiting", and so on, that I realised, as if by a revelation that, apart from the effects of an anæsthetic and except to a trivial degree, patients no longer vomit. This tremendous advance is due to the introduction by Wangensteen of the routine use of continuous gastric suction in conditions where vomiting was a predominant feature.

Penicillin and gastric suction then are the flags at peak and mizzen under which this new edition sails out of port, but the yard-arm and ratlines are decorated with bunting, some of which has been washed and ironed from a previous voyage, some is brand new.

Whatever may be said of Service Medicine, its "news service" is unequalled. By means of "Medical Administrative Instructions", "Circular Letters" and "A.M.D. Bulletins", Army Surgeons are minutely informed of advances in every field of Medicine. In a valley by the side of a rocky stream in the Atlas Mountains, seven miles from the nearest Arab village, I was kept more continually aware of surgical progress than when living in London, working at a teaching hospital and attending clinical meetings regularly. I should like here to express my appreciation to those distinguished consultants who, correlating the experience of many surgeons, were responsible for drawing up these memoranda, and hope that they will be pleased to

recognise (in many of the new "pieces of bunting") such of their advice as I was able to try out for myself.

I should like to thank the many unknown reviewers of the second edition for their helpful and friendly criticism. All the suggestions proffered have been examined carefully and discussed with colleagues. In the vast majority of cases amendments or alterations have been made to clear up ambiguities and to correct mistakes, but there is one recurring theme that requires special comment. It has more than once been suggested that the value of the book would be enhanced by a description of the technique of blood-transfusion. When I first undertook the writing of this book I tried to keep in mind the difference in meaning between the terms "technique" and "method". I felt that the former could only properly be acquired by practice under supervision; the latter might be learnt from books. Consequently I purposely refrained from discussing the technique of transfusion, spinal puncture, paracentesis of the chest, and other manœuvres which can only be learnt at the bedside. As the book developed and with fresh editions I am aware that technical manipulations have received more attention than I had originally intended, but for the most part these have been described because they are either new, simple to perform, or essential to the argument. Further, the technique of blood- and plasma-transfusions depends so essentially on the type of apparatus used that a detailed description of the method to include all the patterns generally available would have taken up an unwarranted amount of space in a book which I try to keep as short as possible

In preparing this edition I have taken some trouble to investigate the results of treatment in those conditions about which there are conflicting schools of thought. In discussing these I have tried to be as fair as possible, and where I have advocated a certain line of treatment I have been careful to state that this advocacy is based on reasons which are *in my opinion* valid. This investigation has, however, impressed on me a fact which is well known in the world of controversy, namely that the less the difference between the value of two points of view the more bitterly it is contested. Where, as the lawyers say, *res ipsa loquitur* there is no need for crossed swords or cross words. Without wishing to be didactic, I should humbly like to enter a plea for the use of more moderate language in the expression of opinion in regard to medical matters

The English language is rich in epithet, flexible in quality and, by the delicate interlacement of words, can enliven the expression of every shade of meaning I am very much afraid that medical men

(more perhaps than any other of the learned professions) seriously abuse this finely tuned instrument. To use the terms "always" and "never" is to assume great responsibilities; and an expression with which we might readily dispense is "absolutely criminal" (whatever that might mean), when used, for instance, to stigmatise a method of treatment which differs in some inessential particular from that which the speaker has, perhaps for the last few months, been in the habit of practising. Many years ago I was told that to put on a spinal jacket without cutting a window over the epigastrium was "absolutely criminal". For years I laboured under a sense of guilt until I saw the illustrations of "windowless" spinal jackets in Watson Jones's book, when I felt that my burden was eased; at least there were other criminals. Last year, while I was warded, a colleague took over my patients. After three days he came bursting into the sick room; one of my M.O.'s had been caught making a window in a spinal jacket. Didn't I think that this was "absolutely criminal"? I felt as though I had been released from prison.

The real "criminal" actions in Medicine are neglect, dishonesty and carelessness. Let those who roundly abuse all who disagree with their pet theories remember that we cannot all be brilliant innovators, and sometimes the less brilliant and less raucous have compensating qualities—they may even be kind to their patients.

My thanks are once more due to those who have helped in this as in previous editions with advice and encouragement and I trust that, with the coming of more settled times, I shall be able to relieve them of part of the burden which they have selflessly borne during my enforced absence from home.

HEDLEY J. B. ATKINS.
Temp. Lieut.-Colonel, R.A.M.C.

NAPLES, 1945.

PREFACE TO SECOND EDITION

Faced with the imminent possibility of being transported, if not into another sphere, at least into another hemisphere, I come to the last of the interesting parts in the preparation of this second edition, namely writing a preface. The proof-reading and production I shall have to leave to my father, who has once more loyally undertaken the correction of the typescript.

A new chapter has been added on the post-operative treatment of children, and I am grateful to Mr. Denis Browne for the advice that he has given me in respect to this. The subject of Rehabilitation, which is assuming increasing importance in modern therapeutics, has been given a chapter to itself.

There are new sections on post-operative coronary thrombosis and the management of the diabetic patient in the post-operative period. Major Blackburn has read through the chapter on genito-urinary surgery and with his help this has been thoroughly revised. The section on head injuries has been brought up to date and now incorporates much of the teaching of the Oxford school. Air Commodore C. P. Symonds has kindly read through and corrected the typescript of this section.

There have been various other amendments and additions such as a revision of the sections on fluid administration and anaerobic infections; the addition of small sections on the technique of wound dressing, post-operative adhesions, ruptured kidney and walking appliances for plaster cases ; and an appendix relating the Imperial or Apothecaries' to the metric systems.

In dealing with fractures, the terms " closed " and " open " have been substituted for " simple " and " compound ", in accordance with modern practice. Of the thirteen new illustrations, I am indebted to Messrs. Down Bros. for Fig. 61 and to Messrs. Thackray for Fig. 31.

It is again a pleasure to record my grateful thanks to Messrs. Blackwell the publishers who, battling with paper shortage, dearth of printers and type-setters, and a dozen irritations and restrictions associated with war-time publication, have succeeded in overcoming all their difficulties with an urbanity and a uniformly helpful good humour which has made our association a very happy one.

Hedley J. B. Atkins.
Temp. Lieut.-Colonel, R.A.M.C.

Davyhulme, *October* 1942.



INTRODUCTION

With the advent of John Hunter, Surgery emerged from the "dark ages" of outworn convention into the light of scientific experiment. Hitherto, a thing was true because Galen had taught it; now it was true only if it could be shown to be so. The field of Surgery expanded, and on that field grew a healthy and abundant crop raised from the seed of experiment and fertilised by observation. This period was devoted to the study of wounds and of infected tissues. The surgeon's home was the ward, and here he observed the living pathology of infection, healing and repair. Without the aid of laboratory methods or radiography clinical acumen was at a premium. Bright, Addison, Hodgkin and Trousseau in the field of Medicine, and Astley Cooper, Cheselden and Dupuytren in the field of Surgery, described the symptoms and signs, the anatomy and pathology of diseases hitherto unrecognised. This was the age of classification and collation. Operations were few and far between; the technical advances which were to make these an everyday occurrence were yet to come. Such operations as were undertaken had to be performed with dexterity and rapidity to save the patient from insufferable agony. Like a flower blossoming in this field came the publication of Hilton's *Rest and Pain.*

In the middle of the nineteenth century the whole orientation of Surgery was shifted by the work of Simpson on anæsthetics and Lister on the control of infection. Operations became more common, and surgeons, inspired by the possibilities of this new field, became technicians, so that surgical technique in the modern sense was born. Advances in Operative Surgery were made rapidly and no organ was exempt from the encroachments of the surgeon's knife. The surgeon moved his home to the operating theatre and the ward became his week-end cottage. Reigning over this hierarchy of inspired technicians was the greatest craftsman of them all—Arbuthnot Lane. Such were the developments in the field of Operative Surgery that Moynihan may not have been far from the truth when he stated before he died that surgical technique had reached its highest peak.

What of the future? Slowly but surely there is a drift back from the theatre to the ward. Surgeons are coming to realise that, in their "gold rush" from the first field to the second, much had been left behind that was uncultivated. In nine cases out of ten one surgeon of

experience will perform the operation as well as another and, if our results are to improve, it will come once more from a study of the processes of healing and repair. We appreciate that when the patient leaves the theatre our job is but half done and that the convalescence, the subsequent health, or even the chances of survival may be prejudiced by the kind of after-treatment which he will be given. In the last ten years advances in after-treatment have been as rapid and as valuable, if not so spectacular, as the advances in technique in any decade of what we may call the period of technical achievement. Surgeons are mostly aware of these advances and are taking an increasing interest in them, but Surgery is an exacting occupation. The physical and mental strain of operating, the time spent in the outpatient department, the demands of teaching and private practice, and the fact that many of his cases may be operated on far from his home make it impossible for the surgeon to supervise the after-treatment of all his cases personally. For this reason it was felt that the time had come for an account of the recognised methods of treatment in the post-operative stage.

This book is written for those who are called upon to undertake the care of patients at this stage, and although the term " after-treatment " is often used as if it connoted post-operative treatment only, yet it is from time to time used in its broader sense. Thus " After-Treatment " is made to include the *treatment after* certain injuries, such as burns, concussion and contusion, the management of which is likely to come within the province of those for whom the book is primarily intended. On the other hand the treatment after such highly specialised operations as craniotomy for cerebral tumour, lobectomy, thoracoplasty and plastic operations has not been dealt with. It was felt that the after-treatment in these relatively new fields was by no means standardised and that, as these cases were tending naturally and properly to gravitate to special centres, their after-treatment would not normally come within the purview of the general practitioner or the sisters and housemen of a general hospital. Having in mind the readers rather than the title of this book, I have added appendices on " Writing Reports " and " Appearing in Court " It is hoped that their inclusion may be excused on the grounds that they will prove helpful to the medical man called upon, as it were, to play away from home.

In writing the text I have had no compunction in borrowing from every source which was available both literary and personal. I trust that due acknowledgment has been made in the proper place for these depredations, but if there are any omissions, it is because one builds up one's store of knowledge from so many sources that it is often

impossible to remember its origins. There are, however, three works which I should like particularly to mention: *Fractures and Other Bone and Joint Injuries*, by Watson-Jones; *The Principles and Practice of Rectal Surgery*, by Gabriel; and *Diseases of the Thyroid Gland*, by Joll. These three books are monuments to British Surgery. Nowhere else in the English language are there to be found such authoritative, complete and clear accounts of their respective spheres, and it is a pleasure to be able to record the debt which I owe to each.

To Sisters Falwasser and Harrison, who have saved so many of my patients from the consequences of mediocre surgery, I should like to express my sincere thanks for their co-operation and help. Watching over me as each chapter has been written has been Mr. Wass, senior Registrar at Guy's Hospital, who, in the course of years, has wisely separated the gold from the dross in the teaching and practice of those for whom he has worked and has unstintingly given much of his time and thought to amending and correcting the text. Directly and indirectly much of what is written here is derived from my colleagues on the Staff of Guy's Hospital, and I must thank them for all that they have taught me in the past. I should like to mention particularly Professor Ryle and Mr. Slesinger who, by the accident of propinquity, have been closely associated with me during the past two years and whose interest in the subject of after-treatment has been of the greatest value. Mr. Robin has helped me with the writing of the chapter on the "Ear, Nose and Throat", and his experience in oto-rhinological clinics both here and abroad has been put freely at my disposal.

For permission to reproduce Figs. 9, 12, 18, 21, 22 and 26 I am indebted to Messrs. Allen & Hanburys; for Figs. 35 and 36 to Messrs. Down Bros.; and for Figs. 41, 42 and 43, to Messrs. Desoutter. I should also like to thank the above firms for the loan of plates and blocks. Miss Newman, of the radiological department, Guy's Hospital, has been responsible for the photographic illustrations.

Messrs. Blackwell the publishers, besides being instrumental in launching this project, have spared no trouble in gratifying an author's whims. Much of the pleasure which I have derived from producing this book has been due to their encouragement and help.

Throughout I have received the unfailing assistance of my father, who has taken the greatest care in correcting and amending the script and in reading the proofs. It is impossible to say how much I owe to him, both in the matter of writing this book and for his past advice and friendship, and I can only hope that our partnership on this occasion has been an experience as stimulating and enjoyable to him as it has been to me.

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Finally, it is with much pleasure that I record the enthusiastic help of my secretary, whose lively interest and avidity for copy were a great stimulus at a time when man's highest achievement seemed to be a capacity for dodging fallen masonry and metal.

HEDLEY J. B. ATKINS.

NUFFIELD HOUSE, *March* 1942.

CHAPTER I

EARLY POST-OPERATIVE TREATMENT

GENERAL CONSIDERATIONS

The Patient and the Sick Room

The satisfactory management of a sick patient demands a combination of qualities some of which are innate and some acquired. The inborn qualities are honesty, common sense, sympathy, a sense of humour and a reasonable degree of self-assurance such as will command confidence. The acquired qualities are knowledge, judgment and understanding to which must be added great patience. The practice of medicine is not an intellectual pursuit, and intellectual doctors, if they are successful, sublimate their powers in the study of philosophy, " pure " science or the arts.

If these qualities are desirable in dealing with sick patients as a whole, they are of even greater importance in dealing with patients who have undergone an operation. Such patients, besides being ill, are generally in strange surroundings and have just recovered from what is probably the most dramatic experience of their lives. The note in the doctor's diary, " 9.30 a.m. Mrs. Smith, gall-bladder ", nearly always implies that for an indefinite period the whole routine of Mrs. Smith's life will be upset in a painful and alarming way. Her household will, in her opinion, go to rack and ruin and her children will be uncared for, if not starved. It is not to be wondered at that she often reacts unfavourably after the operation. On the morning of the operation she may be sleepy from the effects of a hypnotic administered the night before, but she will have " screwed her courage to the sticking point " and with a sense of excitement and some foreboding she surrenders herself to the ordeal.

Immediately after the operation and during the recovery from the anæsthesia, restlessness may be extreme. Some surgeons make a practice of giving 50 grains of potassium bromide in a pint of 5 per cent. glucose in tap-water by the rectum as a routine as soon as the patient gets back to bed. This is a most effective measure which might with advantage be more widely employed. Generally morphia will be required and a ¼ grain should be given hypodermically as soon as the patient begins to stir. For children, Omnopon in doses of a minim

for each year of age is a satisfactory method of giving morphia in very small doses (page 5). So far as is possible, forcible restraint of the patient must be withheld, as this only excites more frantic efforts.

After a moderately severe operation the impressions of the patient when he has recovered consciousness are usually hazy and he is poorly orientated. Although he may experience a sense of relief at finding himself still alive, it is not until the following day that he wakes up and can say to himself with a full sense of realisation " it is all over ". The day following the operation is usually coloured by this feeling of exaltation. The patient is cheerful and makes light of his symptoms. He often expresses a desire to read and receive visitors without realising that these activities would be too much for him, and on the second day after the operation the reaction sets in. He may complain that he does not feel so well as on the preceding day. He has got used to the idea that he has survived the ordeal and is irritated that his survival is attended by so much discomfort, pain and nausea. It is at this stage that the problems of convalescence really begin.

The patient should be made comfortable in bed by the proper placing of pillows to support the back and the head. The eyes should be protected from the direct beam of bright light and the room should be well ventilated but free from draught. *The temperature of the sick room* is conveniently kept at about 65° F., but the patient's own feelings must not be disregarded. A young patient is willing to submit to the opinion of others in these matters, but an old gentleman who has slept for many years in a room with all the windows shut and a gas-fire on will not be happy unless these conditions are reproduced for him in the sick room and the period of recovery from an operation is not the time to instruct an unwilling pupil in the principles of hygiene. Of all methods of heating, coal fires are probably the best ; but it is not often possible to install these in institutions on account of the expense and extra work entailed If the patient would like it, the windows should be widely opened and the risk of chill can be prevented by covering the head and ears with a shawl. *Oral hygiene* is important at this stage. The teeth and tongue must be kept clean and antiseptic mouth-washes are valuable in the prevention of post-operative parotitis. Following all intra-oral operations where the lips and cheeks have been distorted by gags and retractors, the mouth should be liberally smeared with Vaseline To the nursing staff falls the responsibility of the prevention of bed-sores, and this problem is dealt with in a discussion on spinal injuries. Morale is often encouraged by the attentions of a barber.

As time wears on, unless he is making obvious progress, and without any physical reason to account for it, the patient may go downhill. Often a change of scenery works wonders, and moving him to another room or even shifting the furniture in the room in which he lies may serve to break the monotony of the days. 50 grams of glucose by the mouth and 10 units of insulin by injection may be given daily to a patient who is losing ground in this way.

Friends and Relatives

The problem of friends and relatives is one that must be faced with tact and resolution. A good plan is to select one sensible person from the throng, chosen if possible by the patient himself, and allow him (or more usually her) some degree of liberty in regard to visiting. This person may see the patient for a few minutes when he has recovered from the anæsthetic and on succeeding days for variable periods as circumstances allow. Additional visitors, with very few occasional exceptions, should be disallowed for the first week, after which the patient will be more fit to entertain them. The doctor can often protect the patient from persons whom he does not really wish to see, but whom he is unwilling to offend, by taking this responsibility upon his own shoulders. A relaxation of the rule can always be made at the express request of the patient himself.

Diet

The question of diet is discussed further in the sections dealing with the abdomen and special rules apply in particular cases. On the whole nature prompts the appetite to desire those things which are beneficial, and when the patient " feels like getting on to something more substantial " it is usually safe to indulge him. As a general rule only fluids are taken on the day of the operation, but on the following day (except after certain abdominal operations involving gastric and intestinal resections, *vide infra*) solid food in the form of bread and butter or minced fish can be readily digested and a hot cup of tea is often a balm to both body and soul. Difficulties of feeding are largely psychological and encouragement from the nursing staff may be required. In these circumstances it is better to put only a very little food on the plate, so that the patient is not discouraged by the immensity of the task before him. The way in which the food is served is most important. Steamed fish capped with black skin, bones protruding and the whole swimming in a mixture of milk and oil will make the stomachs of strong men heave. A glass of

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Chloral

Chloral, prescribed as:

℞ Chloral. hyd.	gr. xv
Pot. brom.	gr. xv
Syrup. Tolu.	ʒ i
Aq. dest. ad	℥ i

is useful when the barbiturates are unsuitable because they are found to produce a "hangover" or cause skin disorders. For *children* it can be prescribed as:

℞ Chloral. hyd.	gr. ij
Pot. brom.	gr. ij
Syrup. aurant.	♏ xv
Aq. dest. ad	ʒ i

in doses of 1 drachm for each year of the child's age, with a maximum dose of 4 drachms.

Phenobarbitone gr. i is indicated in such nervous disorders as migraine, petit mal, epilepsy and vertigo. *Sedobrol*, 1 tablet dissolved in 100 c.cm. of hot water, is also satisfactory in these conditions. *Paraldehyde* (ʒ i per stone body-weight, maximum ʒ x) per rectum is given in cardiac cases because it has no depressing action on the vaso-motor centre, and in mental disorders (where a sedative must be prescribed over long periods) because it is not habit-forming.

Analgesics

For control of pain *Morphia* holds first place. In the early stages when vomiting precludes administration by the mouth it is given as a hypodermic injection in quarter of a grain doses to an adult. Children up to the age of twelve tolerate only very small amounts, prescribed as *Omnopon* in doses of a minim for each year of age, with a maximum dose of 10 minims. Some patients, although relieved of their pain, are paradoxically rendered wakeful by morphia, and for such patients *Heroin* gr. $\frac{1}{16}$–$\frac{1}{12}$ may be substituted at night. Later in the post-operative period for adults *Omnopon* gr. $\frac{1}{3}$ or *Nepenthe* ♏ xx–xxx and for children *Tinct. Opii* ♏i–x may be given by the mouth.

For intolerable pain of long duration, such as is induced by *secondary deposits of carcinoma* in the spine, *Dilaudid* gr. $\frac{1}{32}$–$\frac{1}{16}$ is more satisfactory than morphia, because it has not the same depressing effect

sherry or some tasty morsel can be suggested to stimulate the failing appetite.

Sleep

The problem of procuring sleep is often one of great difficulty in the post-operative period. A good deal depends upon efficient nursing on the lines suggested above. Pillows must be comfortable and the temperature of the room regulated to suit the patient. The bladder and bowels must be attended to and sponging of the face and hands has a refreshing but sedative effect. Above all it is important not to make too much of "settling for the night". If the patient is left comfortable and warm he may select his own time for dropping off to sleep. Nothing can be more irksome than the disciplinary "lights out at nine", and the sudden insistent hush, when every moment that he remains awake quickens his sense of guilt and lays the foundations for a sleepless night. A sick patient lying in bed all day can often do with quite short periods of sleep and at least he has the whole twenty-four hours in which to choose his time. The question of drugs is dealt with below, but whatever sleeping draught is prescribed, it may be placed by the bedside and the time for taking it can generally be left to the patient, when it will then procure its maximum effect. Elderly patients sometimes sleep comfortably on their sides with a pillow between the knees and another arranged lengthwise beside the head to support the free arm. A "nightcap" of Horlicks or Ovaltine is often advisable, whilst for those who are used to it, whisky or brandy may be indispensable.

The use of drugs to induce sleep is generally necessary in the post-operative period.

Sedatives. *The Barbiturates*

Sodium amytal gr. ij–iij is perhaps the most valuable. If there is slight pain from a wound or discomfort from splints, this may be combined with 10 grains of aspirin or Veganin.

Medinal . .	gr. v–x	Allonal	gr. v–x (2–4 tablets)
Nembutal . .	gr iss–iij	Dial .	gr. iss–iij (1–2 tablets)
Evipan (by the mouth) .	gr. iv–viij (1–2 tablets)		

are satisfactory substitutes for sodium amytal, and some patients react better to one of these drugs than to the others. The most satisfactory sedative for a particular patient can only be found by experience.

effects of shock and the effects of blood-loss, because the treatment of the two conditions is not quite the same. In many ways the clinical pictures of hæmorrhage and of shock are akin, and in many cases they are combined. Thus, the deterioration of the patient's general condition, the rapid pulse, the low blood-pressure and pallor are common to both. In both, too, fluid is lost from the circulation. In the one case, however, red blood has been spilt and the volume of circulating fluid is, after a while, made up by absorption of fluid from the tissues, so that the remaining blood is eventually diluted and the hæmoglobin concentration falls; in the other plasma escapes from the dilated capillaries, which are a feature of shock, and the blood becomes concentrated, but the volume remains reduced. Where there is both shock and hæmorrhage, the effect on the hæmoglobin concentration is variable, depending upon which is the more severe.

Provided that this difference in pathology is borne in mind, the measures adopted to treat these two conditions follow the same lines and can conveniently be described together. Let us consider a patient who has just undergone a severe operation and who awaits *transport from the theatre*. The first essential is that all movements of such a patient should be carried out with the greatest care. Lifting from table to trolley and from trolley to bed must be gentle. Rough handling or unnecessary turning must be avoided, as every movement tends to aggravate shock. Within the limits imposed by these considerations the patient should be got back to bed as rapidly as possible to minimise the cooling which occurs as he is wheeled through unheated passages. He should be covered in transit by blankets which have been warmed in the theatre during the operation.

The bed to which the patient returns should have been warmed, if possible by an electric cradle or electric blankets, but if these are not available then by means of hot bottles (well protected by flannel wrappings) and hot blankets. Great care must be taken to see that the patient does not become overheated. If this happens he will begin to sweat and precious fluid is lost. The foot of the bed should be raised on blocks so that the circulation to the vital centres does not have to compete with gravity, and as soon as the patient begins to come round from the anæsthetic he should be given a quarter of a grain of morphia hypodermically to allay pain and restlessness Fluid is given according to the principles described below.

The Administration of Fluid

Fluid may be administered as follows: by the mouth, by the rectum, intravenously, subcutaneously and intramuscularly. In

and it does not lead to vomiting. A valuable prescription for these cases is:

℞ Dilaudid	gr. $\frac{1}{16}$
Amidopyrin	gr. v
Aspirin	gr. v

For lesser degrees of pain *Veganin* in ten-grain doses is probably the most effective drug at our disposal.

Delirium Tremens

Fractures and operations in chronic alcoholics are especially liable to be followed by delirium tremens. When dealing with such patients, *moderate doses of alcohol, in the form in which they are used to taking it*, should be prescribed after operation. When an attack has occurred, however, there is no purpose in giving alcohol in an attempt to abort it. The services of a male nurse who should exercise tactful restraint will probably be required. Fluids and glucose are prescribed freely and morphia may be given, but is often without much effect. In addition 7 c.cm. of paraldehyde may be injected intramuscularly into the buttock, or in a severe case intravenous Pentothal may be required to quieten the patient. In some cases bed-boards to prevent the patient throwing himself out of bed will be necessary, but all endeavours to save him hurting himself should be carried out as inconspicuously as possible.

Shock and Hæmorrhage

After an operation involving prolonged manipulations inside the peritoneal cavity, where much blood has been lost, where cooling of the tissues has been allowed or has been inevitable and in many other instances the patient will be suffering from a condition known as shock. It is not possible to define "shock" except in the most general way, because we do not know precisely what we mean by the term. We do know that the syndrome so described is due to a combination of many factors, any one of which may be exerting a preponderating influence in a particular case, and all we can say is that as a result of loss of heat, loss of fluid, tissue-trauma, pain or a combination of these factors, a patient is reduced to a state where he feels ill, the pulse is rapid and thready, the blood-pressure is usually low, the skin commonly grey and clammy and death may ensue. This state we term "shock". Without going into the pathological processes involved in the production of this state, it is necessary to distinguish broadly between the

unable to drink, and at this stage fluids by the mouth would encourage vomiting, so that other routes must be employed. The most rapid and the most logical way of making good the loss of blood or plasma is to inject blood or plasma into the circulation and an intravenous infusion apparatus should therefore be set up. If means are not available for this, physiological but non-vital fluids, such as 5 per cent. glucose solution or normal saline, may be given per rectum or subcutaneously. If the intravenous route is used, then blood, plasma, serum or gum-saline may be given. Blood should be used where blood has been lost and is therefore of greatest value in cases where hæmorrhage has been the predominant feature. Where shock is unaccompanied by hæmorrhage (as in second-degree burns—*vide infra*), and where therefore the hæmoglobin concentration is raised and the thick blood tends to stagnate in the dilated capillaries, whole blood by infusion will do nothing to relieve this and plasma or serum is to be preferred. Where the effects of both hæmorrhage and shock are present (a diagnosis which is made from a consideration of the patient's condition, together with a rough knowledge of the amount of blood lost and the extent to which the patient has been subjected to shock-producing agencies), then a preliminary infusion of blood equal to the estimated volume lost, followed by one of plasma or serum, is the most satisfactory treatment. If blood is transfused, then blood from an appropriate group must be used, and before transfusion this must be "cross-grouped" with the patient's own blood. Plasma and serum are of equal value. With plasma or serum transfusions in amounts up to 500 c.cm., grouping is not essential; if more than this volume is to be transfused, then the material injected should be "grouped". Gum-saline is a substitute for blood or plasma, but is said to be responsible for a higher proportion of undesirable reactions and cannot obviously be quite as effective as the natural fluids.

As soon as the patient is revived the intravenous infusion should be stopped After forty-eight hours at the longest, if the patient has not succumbed, recovery will ensue. This is assessed by a consideration of the patient's general condition and by the skin-temperature of the nose and forehead; or more objectively and with greater accuracy by observing the blood-pressure to rise and the pulse-rate to fall.

The total volume of blood or plasma given intravenously must depend upon the patient's response. In a mild case of shock about 2 pints will probably be sufficient. In a severe case 6, 7 or even more are indicated. It is usual to give the first pint in about ten minutes and subsequent pints by the drip method, allowing two to three hours for each pint.

practice the first three methods are the most reliable and the accompanying table shows the indications and contra-indications for their use.

	Indications	Contra-indications
The Mouth	Whenever possible.	Unconsciousness. Vomiting. Acute gastric dilatation, peritonitis, paralytic ileus. Where vital fluids (blood, plasma, serum) are required.
The Rectum	Unconsciousness. Vomiting. For short periods (up to 48 hrs.).	Acute gastric dilatation, peritonitis, paralytic ileus. Low colonic anastomosis. Where vital fluids (blood, plasma, serum) are required.
Intravenous	Acute gastric dilatation, peritonitis, paralytic ileus. Low colonic anastomosis. Where vital fluids (blood, plasma, serum) are required.	Pulmonary œdema.

Fluids for Hæmorrhage and Shock (Blood and Plasma)

In considering the administration of fluids to patients suffering from hæmorrhage or shock, a distinction must be made between post-traumatic and post-operative cases. In the former there is not the complicating factor of the anæsthetic and often sufficient fluid can be given by the mouth to make up for that lost as a result of the hæmorrhage or shock. In air-raid casualty cases it was found that a cup of hot, well-sweetened tea or coffee was of considerable benefit to shocked patients or patients who had lost blood, the only contra-indication to this measure being unconsciousness and a suspected or proven abdominal injury. In some cases, however, the volume of tea or coffee which the patient was able to drink may not have been sufficient to restore his fluid level and this was indicated by a persistently rapid pulse, pallor, coldness of the extremities (where these were not heated by an electric cradle), and a systolic blood-pressure below 95 mm. Hg. Where such symptoms persisted, blood, plasma or serum was given intravenously according to the principles enunciated below.

In the post-operative case the semi-conscious patient will be

in very large amounts. If the fluid is being given by a vein, isotonic solutions must be used, otherwise the vein wall is irritated and a phlebitis is caused. Consequently, if we were giving fluids intravenously to a healthy adult, 4 pints of 5 per cent. glucose in distilled water and 1 pint of normal saline in the twenty-four hours would roughly meet his requirements. It is important not to give too much saline, otherwise the kidneys may not be able to excrete the excess sufficiently rapidly and salt is retained in the tissues. This salt retention leads to tissue œdema by osmosis and is consequently a cause of pulmonary œdema. Swelling of the loins (" lumbar pad "), of the ankles or moist sounds at the lung bases are danger signs in this respect (p. 95). If too little salt is being given, it will disappear from the urine, and this is readily discovered by adding silver nitrate solution to the urine. An absence of a cloudy deposit indicates that more chloride is required. A more exact method is to regulate chloride intake so that approximately 3 grams of chloride are excreted in the twenty-four hours. Ten drops of urine and one drop of 20 per cent. potassium chromate are added to a test-tube by means of a fountain-pen filler. A solution of 2·9 per cent. silver nitrate is then added drop by drop until the colour of the solution changes from yellow to brown. The number of drops of silver nitrate used gives the number of grams of chloride per litre of urine. The volume of the intravenous intake outlined above was assessed from the needs of a healthy individual. In acute gastric dilatation, peritonitis and paralytic ileus, in addition to the natural water-loss and the natural metabolism and excretion of salt, water and salt are lost in the vomit or by gastric suction, in the increased perspiration, in the fluid stagnating in dilated coils of intestine and in the fluid draining into the dressings via drainage tubes. Thus, in these conditions more than 5 pints of fluid in the twenty-four hours are required and more salt than is contained in 1 pint of normal saline is needed. When there is much vomiting, where much fluid is being drained away by the indwelling stomach-tube or where paralytic ileus is extreme, as much as 8 pints in the twenty-four hours may be required, of which four may be normal saline and four 5 per cent. glucose in distilled water, a check being kept on the saline intake by testing the urine for salt.

These large quantities of fluid help to keep the kidneys functioning and tend to wash away toxins. In a case of peritonitis, if the kidneys can be made to excrete more than 40 ounces of urine in the twenty-four hours, the prognosis is good. To keep a check on this, the fluid intake, the vomit and the volume of urinary output should each be charted.

FLUID MAINTENANCE APART FROM HÆMORRHAGE AND SHOCK (SALINE AND GLUCOSE)

In general, fluid administration presents no problem. A few hours after many operations a patient can, without vomiting, begin to sip small quantities of water or barley-water, starting with half an ounce in an hour and working up to 3 ounces an hour within twelve hours of recovery from the anæsthetic. Later the fluids are thickened, and the salt and sugar intake becomes automatically sufficient as Bovril and soups are given in addition to the sweetened lemonade or barley-water. In some cases, however, where vomiting is copious, where there is peritonitis and after certain operations on the stomach, fluid by the mouth must be withheld for a variable length of time. In these cases the fluid may be administered per rectum or intravenously. Lately the giving of fluid by a drip intramuscularly has been elaborated, but it is still too early to say how far this method will replace the old well-tried routes.

The Rectal Method

This is ideal where, as after gastro-jejunostomy or gastrectomy, it is not anticipated that the procedure need be prolonged for more than twenty-four hours and where there is no contra-indication such as low colonic anastomosis or paralytic ileus Although prodigious quantities of fluid have been given and have been retained by the rectum, it cannot be relied upon to absorb more than about 5 pints before it becomes irritated and tends to return the fluid, but this volume may be increased by resting the rectum for two hours between each infusion. A solution of 5 per cent. glucose in tap-water is most readily tolerated by the rectum, and this should be run in through a catheter which has been well lubricated and is joined to a drip-feed apparatus regulated to deliver a hundred drops a minute.

The Intravenous Method

In such conditions as acute gastric dilatation, peritonitis, paralytic ileus and low colonic anastomosis, where the artificial administration of fluid may have to be prolonged for many days, where the excretory function of the rectum is more important than the absorptive or where a tender suture-line lies just above the rectum, the intravenous route is to be preferred. Over such periods not only must the level of fluid intake be maintained, but the needs of the body for *salt* and *glucose* require consideration. Physiologically an adult requires about 5 pints of fluid in the twenty-four hours and about as much salt as is contained in a pint of normal saline. Glucose can generally be tolerated

very little attention. A *Ryle* or *Jaques tube* is passed, preferably through the nose, and may be introduced, if required, at the conclusion of the operation in the theatre while the patient is still under the anæsthetic. If it is passed later the tube should be placed coiled up in a saucer containing paraffin to which some cubes of ice have been added. After three or four minutes the cold, lubricated tube will be readily swallowed. When peristaltic sounds are re-established in a case of peritonitis or paralytic ileus and after twenty-four hours in other cases, the gastric tube is clamped off and the patient takes an ounce of fluid an hour for two hours, two ounces an hour for two hours, and so on until four ounces an hour are accommodated by the stomach without distress and without vomiting. As soon as this is accomplished the gastric tube is withdrawn and intravenous fluids, which will in most cases have been necessary (*vide supra*), are stopped. Such measures have rendered the postural treatment of gastric dilatation obsolete, and the patient may be allowed to remain comfortably propped up in the Fowler position.

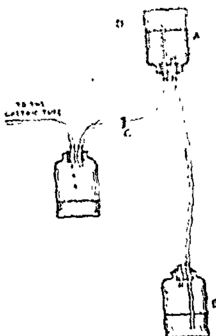


FIG. 1 —Gastric suction ...
bottle A ...
bottles A ...
glass tub ...

This treatment implies that the fluid intake of the patient must be by means other than via the mouth and a rectal or, more usually, an intravenous infusion must be set up.

Hiccough

This distressing complication, which is caused by spasm of the diaphragm, may be due to gas distending the stomach or other benign cause, but is always suspicious of upper abdominal peritonitis. The treatment of peritonitis is discussed in Chapter VI, but the hiccough itself may be so severe as to cause exhaustion, prostration or even death. At first the homely remedies may be tried such as holding the breath, sipping fluid, taking a teaspoonful of vinegar (half-strength for children),

Vomiting

Vomiting is a common and distressing complication of operations. Inhalation anæsthesia is peculiarly liable to lead to this complication, and although " post-anæsthetic " vomiting is not in itself serious, it causes painful tension in an abdominal incision and may even lead to bursting of the wound. Mildly antiseptic and deodorant mouth-washes are of value in cleansing the mouth after the vomit, and a reassuring and sometimes determined attitude on the part of the nurse in charge may help to prevent fresh bouts. A few patients make up their minds to vomit and literally wallow in their misery, but with a little encouragement most will try to control their vomiting, although some become exhausted by repeated attacks despite every effort. Vomiting of a hysterical nature is usually noisy and accompanied by much retching and but little vomitus.

There are many measures recommended for the control of post-anæsthetic vomiting. *Acid. Hydrocyanic. Dil.* or *tincture of iodine* in 2-minim doses may be successful, but perhaps the pleasantest and most effective way is to give the patient small cubes of *pineapple* to suck. The juice has a cleansing effect on the mouth, and being acid tends to render the mucus more tenacious and less readily vomited, whilst the pith adds bulk to the stomach contents and allays the violence of the spasmodic contractions. An attempt should be made to get the patient to take small sips of fluid sweetened with glucose, and it is often found that these are satisfactorily retained. Thickened foods such as Benger's are sometimes kept down when more watery solutions are vomited If glucose cannot be retained when given by the mouth, 4 oz. of glucose in a 5 per cent. solution may be given by the rectum, followed in twenty minutes by 5 units of insulin by injection.

If the vomiting persists for more than twelve hours then it must be due to some factor other than the anæsthetic. Incipient *acute gastric dilatation* or *peritonitis* must be suspected. Although acute gastric dilatation is characterised by the effortless vomiting of large quantities of mucus, it is important to recognise that the early stages are often associated with nothing more than a little epigastric discomfort. It is often advisable and may be a life-saving measure to perform an " exploratory " wash-out of the stomach on a patient who is " not doing well " When either acute gastric dilatation or peritonitis is evident, a *gastric suction* apparatus should be set up (Fig. 1). The introduction of gastric suction has saved countless lives and it should be instituted prophylactically in any case in which peritonitis is suspected or anticipated. The method is simple to apply and requires

operation. When all else fails, a catheter must be passed, but this is a confession of failure, and once it has been performed a patient tends to rely upon it in the future and the disability will not be so rapidly overcome. On the other hand the bladder must not be allowed to become over-distended and, if the patient has not succeeded in passing water after eighteen hours, a catheter must be passed.

Bowels

Apart from the special difficulties in getting the bowels open in patients suffering from a paralytic ileus and peritonitis and in addition to the problems of bowel movement after certain abdominal operations, both of which are dealt with below, the very fact that a patient is confined to bed will tend to cause constipation and this must be treated.

No concern need be paid to failure of the bowels to act until the third day after an operation. If by that time no motion has taken place, an adult patient should be given Cascara Evacuant ʒ ij on the evening of the third day and this may be followed in the morning by magnesium sulphate ʒ ij, or by some other more palatable concoction of the " salts " type. *Cascara Evacuant* (Parke Davis) is a very effective aperient and not quite so griping as other forms of cascara, though its expense may prohibit its use in hospital, in which case the liquid extract of cascara, Pil. Rhei. Co. or vegetable laxative are satisfactory substitutes. Should any of these fail to produce an action, a *soap enema* should be given, although in some cases, before giving an enema, the effect of a glycerine suppository might be tried.

The subsequent treatment of the bowel varies from patient to patient, but there are certain general principles to be observed. The diet should contain as much roughage as is suitable; fruit-juice (especially orange-juice) should be taken freely and plenty of fluid should be constantly [illegible]

point of view of the bowels, the earlier the patient is allowed up out of bed the sooner the regular bowel habits return. To be allowed to sit on a bed-pan on a chair placed beside the bed is of itself a great assistance in the act of evacuation. No call to stool, however trivial, should be neglected, and the nursing staff must show a cheerful stoicism when called upon to produce the bed-pan for what turns out to be a fruitless attempt.

Patients often have a favourite laxative, and if possible they should continue to use this whilst in bed. Usually the habitual dose will require to be doubled. Of the common laxatives paraffin, Petrolagar,

sucking a lump of sugar and applying a mustard plaster or very hot water-bottle to the back of the neck; but if the hiccoughing persists, other methods will have to be adopted. Carbon dioxide in a 30 per cent. mixture with oxygen should be administered by means of a face-piece for five minutes each half-hour. If a carbon dioxide cylinder is not available, breathing in and out of a paper bag serves to raise the carbon dioxide concentration in the alveolar air and produces a similar effect. The stomach may be washed out or, if the hiccoughs are rhythmic, ethyl chloride may be sprayed on to the sternum just before an expected spasm and the resulting gasp may prevent the hiccough. Morphia is the most valuable drug in this condition and may be given in doses up to a third or half a grain if desired. In the last resort a direct attack must be made on the phrenic nerve. Attempts to infiltrate the nerve with local anæsthetic solution may be made, but usually the phrenic nerve on one or other side must be exposed and crushed by Spencer Wells forceps. Crushing of one nerve may arrest the spasms but sometimes both phrenics will require to be crushed and even then the hiccough may persist, but with much diminished intensity so that the patient can regain his strength.

Urine

After certain operations, particularly on the genital organs and in the region of the groin, and in nervous patients or old men with incipient prostatism, passing water may be very difficult.

The bladder should have been empty at the time of the operation, and it is not usually until about six to eight hours later that the patient expresses a desire to empty his bladder. Often leaving a patient alone with a bottle or on a bed-pan will produce the desired result, but some patients are constitutionally unable to micturate lying down and it is often possible to support them in a standing position at the bedside even so soon as eight hours after the operation ; in other cases they may be allowed to sit up with their legs hanging over the side of the bed. The homely encouragement from turning on taps should not be despised ; if this fails, 1 c.cm. of Carbachol may be injected subcutaneously and a fresh attempt made ten minutes later ; or an enema may produce the desired effect. In operations for hydrocele and varicocele where the scrotum has been bandaged on to the abdominal wall and in certain cases of hernia with a tight spica bandage, it may be necessary to loosen the dressings temporarily. It is often found worth while to make a patient, about to undergo an inguinal or scrotal operation, practise passing water in bed with a bandage in place. He will then not be inclined to view the procedure with such apprehension after the

operation. When all else fails, a catheter must be passed, but this is a confession of failure, and once it has been performed a patient tends to rely upon it in the future and the disability will not be so rapidly overcome. On the other hand the bladder must not be allowed to become over-distended and, if the patient has not succeeded in passing water after eighteen hours, a catheter must be passed.

Bowels

Apart from the special difficulties in getting the bowels open in patients suffering from a paralytic ileus and peritonitis and in addition to the problems of bowel movement after certain abdominal operations, both of which are dealt with below, the very fact that a patient is confined to bed will tend to cause constipation and this must be treated.

No concern need be paid to failure of the bowels to act until the third day after an operation. If by that time no motion has taken place, an adult patient should be given Cascara Evacuant ʒ ij on the evening of the third day and this may be followed in the morning by magnesium sulphate ʒ ij, or by some other more palatable concoction of the "salts" type. *Cascara Evacuant* (Parke Davis) is a very effective aperient and not quite so griping as other forms of cascara, though its expense may prohibit its use in hospital, in which case the liquid extract of cascara, Pil. Rhei. Co. or vegetable laxative are satisfactory substitutes. Should any of these fail to produce an action, a *soap enema* should be given, although in some cases, before giving an enema, the effect of a glycerine suppository might be tried.

The subsequent treatment of the bowel varies from patient to patient, but there are certain general principles to be observed. The diet should contain as much roughage as is suitable; fruit-juice (especially orange-juice) should be taken freely and plenty of fluid should be constantly available at the bedside and the patient encouraged to drink it. The question of getting up is discussed below, but certainly from the point of view of the bowels, the earlier the patient is allowed up out of bed the sooner the regular bowel habits return. To be allowed to sit on a bed-pan on a chair placed beside the bed is of itself a great assistance in the act of evacuation. No call to stool, however trivial, should be neglected, and the nursing staff must show a cheerful stoicism when called upon to produce the bed-pan for what turns out to be a fruitless attempt.

Patients often have a favourite laxative, and if possible they should continue to use this whilst in bed. Usually the habitual dose will require to be doubled. Of the common laxatives paraffin, Petrolagar,

Nujol, Alophen, cascara, senna and vegetable laxative are satisfactory. A common practice is to give a dose of salts each morning and the laxative preparation each alternate evening.

Calomel gr. $\frac{1}{4}$–gr. ij may be necessary in obstinate constipation and should always be followed by " salts " in the morning to ensure that the mercury salt is rapidly eliminated from the system. Castor-oil has its enthusiastic advocates and its most vehement opponents, and it certainly has an exceptionally unpleasant taste. *Pil. Col. et Hyosc.* gr. iv is a powerful aperient and will usually stimulate the most sluggish bowel into activity.

For *infants* up to the age of two years olive-oil ʒ i is valuable or Milk of Magnesia, in doses of ʒ i per year of age, is often satisfactory. *After the age of two years* Pil. Rhei Co. gr. ij is best tolerated by children.

Difficulty may be experienced in getting patients to take paraffin or castor-oil If this is so, lemon-syrup diluted with soda-water should be placed in a warm cup, the paraffin or castor-oil is then added and a further layer of lemon-juice and soda poured on top. The whole is then drunk off without pausing.

Enemata may be necessary but are on the whole undesirable. The patient comes to rely on them and they may even be habit-forming. Enemata of gruel, normal saline, soap, treacle, bile and turpentine are probably effective in that order of potency (Appendix I).

Position in Bed

On return from the operating theatre the patient will, if under a general anæsthetic, be laid flat on his back with his head supported by one pillow. As the patient is sleeping off the effects of the anæsthetic he should be left in this position, but at least by the following day, and earlier in cases of peritoneal infection, he should be propped up, using an increasing number of pillows until he is supported comfortably with the trunk at 70° to the horizontal. At night, except in cases of peritonitis where the Fowler position must be maintained, the patient may choose the most comfortable position. The sitting posture is desirable, not only for the sake of localising intraperitoneal infections, but because the chest is able to expand more readily and, particularly in elderly patients, there is less likelihood of " water-logging " at the base of the lungs. This position is maintained by a " donkey " or pillow placed under the knees and tied to the head of the bed Another pillow placed against the soles of the feet and similarly tied, gives the patient something to push against. If there is any difficulty in coughing up bronchial secretions, then the patient can lean over the side of

the bed, first on one side and then on the other, supported if necessary by a nurse, who should place one hand gently but firmly over the site of an abdominal incision. Movement in bed of arms and legs is to be encouraged to stimulate the circulation. After a few days, light massage of the limbs may be given to a patient who is making satisfactory progress and should, if possible, always precede the adventure of "getting up", particularly if the patient has been bed-ridden for some time. After a *spinal anæsthetic* the patient should lie flat without any pillow for twenty-four hours in order to minimise "post-spinal headache". If, however, there is peritonitis, this period should be reduced to six hours, after which the Fowler position must be adopted.

Post-spinal headache can be a most distressing complaint. It is assumed that it is due to reduction in cerebro-spinal fluid pressure as a result of leakage at the point of puncture through the meninges or from excessive loss of fluid at the time of the puncture. There is no conclusive evidence in proof of this conjecture but it is probably correct, as "post-spinal" headache, unlike the majority of headaches, tends to abate when the head is low in relation to the rest of the body.

The treatment is to lay the patient flat, to keep him as still as possible and to block the foot of the bed. At least 5 pints of fluid should be taken in every 24 hours and 1 c.cm. of Pituitrin may be injected subcutaneously every 4 hours. Morphia may be required to bring relief.

Getting Up

The problem of when to allow a patient to get up is so complicated that it is impossible to formulate any fixed rules. Certain general principles, however, should be noted. Firstly, a patient who has had a general anæsthetic and has undergone an operation has often suffered a greater shock to the system than either he or the doctor realises, and with certain exceptions he should not be hurried out of bed. *Young patients* particularly are anxious to get up too soon and a firm line must be taken with them. If against his better judgment the doctor yields to the young patient's importunities in this respect, what usually happens is that the patient, who has been feeling "as strong as a lion" in bed, finds in fact when he gets up that he is "as weak as a kitten". Pride forbids him to admit this, particularly if there has been a struggle to get his own way, and by overtaxing his strength his convalescence is thereby unduly prolonged. *Elderly patients* on the other hand should be encouraged to get up. An elderly patient is often happier and suffers from less cardiac and respiratory embarrassment if allowed to sit well wrapped up in an arm-chair by the fire than

if left to languish in bed. Elderly patients easily become bed-ridden, take longer to overcome the weakening effect of lying in bed and whilst in bed are more liable to chest complications and obstinate constipation. An elderly patient who is dying may well be allowed to return home to sit by his own fireside when purely medical considerations would demand his close confinement in bed in an institution.

After *acute infections* the patient should not be allowed up until the temperature has been normal for three consecutive days An exception to this rule may be made if it is thought that the temperature is due to chest complications, in which case it may be advisable to get the patient up. After *chronic infections* with a long-continued pyrexia, the temperature is not much guide as to when the patient should leave his bed.

As a general rule after operations such as "interval" appendicectomy, partial or total mastectomy, partial thyroidectomy, orchidectomy, operations for piles, fissure and fistula, and operations on the lips or tongue, the patient may be allowed up after a week or ten days; after more severe operations such as cholecystectomy, radical mastectomy, total or subtotal thyroidectomy, gastrectomy, gastro-jejunostomy and resections of gut, the patient may be allowed up after a fortnight or three weeks.

First of all the patient gets up whilst his bed is being made. The following day he gets up for tea. Gradually he is up for longer periods and after a variable time is spending practically all day out of bed. This is the ideal time for him to be discharged to his home. For a further period he should take his breakfast in bed and if possible he should arrange to go away for a holiday of a duration roughly equal to the length of his illness when in the hospital or nursing home. His return to work should, if it can be arranged, take place gradually. For a few days he can go to his work in the afternoon only and he will then soon be fit, mentally and physically, to take up his full duties once more.

In Service patients and other young persons in institutions, organised exercises are of the utmost value in rehabilitation. Chapter XIV contains a table of general and special exercises which may be used with advantage. Stage I of the general exercises may usually be commenced after the patient has been out of bed for a week and Stages II and III may be performed in the third and fourth weeks after the patient has been up For those who require strengthening exercises to the abdominal muscles whilst in bed, the Margaret Morris exercises performed to music from a gramophone may encourage the patients to take an active interest in their rehabilitation. These

exercises may be obtained in book form and with reference to the appropriate gramophone records from any medical publishers.

The Diabetic Patient

Operations on diabetic patients are potentially more dangerous than on normal patients. If the diabetes is well controlled, this increased danger is often negligible; even so, the constant attention of a physician is necessary to organise the pre- and post-operative treatment. The increased risk in the diabetic patient derives from his susceptibility to infection of the wound, infection of the renal tract and to pneumonia, as well as from the possibility of the occurrence of a diabetic crisis such as insulin coma or hyperglycæmia. The precise pathological lesion which is responsible for these tendencies is not known. In the middle-aged and elderly diabetic it is certain that arteriosclerosis is an important factor and it has been said that "a diabetic patient is as old as his age plus the age of his diabetes". The combination of cancer and diabetes is a particularly lethal one and operations on these patients carry a very high mortality.

It must also be remembered that the skin of a middle-aged or elderly diabetic is especially sensitive and additional care must be taken with hot water-bottles and to protect the skin from slight trauma when the patient is coming round from the anæsthetic. Small abrasions, which would heal almost unnoticed in the ordinary way, are apt in these patients to break down and form traumatic ulcers. Diabetics may also be hypersensitive to drugs and the routine post-operative quarter of a grain of morphia should in the first instance be reduced to a sixth or an eighth of a grain until this susceptibility has been tested.

In regard to the regulation of the blood and urinary sugar, the insulin dosage required to maintain a correct sugar balance must be worked out in the pre-operative period. It is not the purpose of this account to discuss pre-operative treatment, but it may be explained that a low carbohydrate diet should be avoided both before and after the operation. The patient should go into the theatre with a liver well stocked with glycogen and to effect this he should, if possible, take at least 250 grams of carbohydrate daily, even if this involves an increase in dosage of insulin. Similarly in the post-operative period the carbohydrate intake should approximate to 250 grams. Throughout, the patient should have a diet low in fat in order to diminish the liability to ketosis. Surgery entails a greater danger of producing hypoglycæmia than hyperglycæmia in diabetic patients who are receiving controlled doses of insulin. The balance in these patients is very readily upset one way or the other, and the increased metabolism which the operation

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after the operation. The aim should be to allow gradually decreasing amounts of sugar in the urine over the first four or five days. If, however, ketone bodies appear in the urine after operation, it is essential to increase the dose of insulin and to give additional carbohydrate.

The pre-operative diet can usually be resumed in semi-solid form after four or five days and a normal pre-operative diet after eight to ten days.

If intravenous glucose is required to deal with post-operative shock, the situation becomes very complicated. Such an infusion inevitably causes a spilling over of excess sugar into the urine without necessarily occasioning a comparable rise in the blood-sugar, so that periodic estimations of the latter become even more necessary. Urinary estimations may be ignored and reliance placed as far as possible on the blood-sugar. As a rule eight units of insulin may be given for each pint of 5 per cent. glucose infused.

Lastly, it must be appreciated that with the removal of a source of sepsis, such as a gangrenous limb, or after draining an abscess, the sugar tolerance may be markedly increased so that in this type of operation the possibilities of hypoglycæmia are materially increased.

occasions may bring about a dangerous state of hypoglycæmia. For this reason the aim of both pre- and post-operative treatment is to keep the balance a little on the side of hyperglycæmia. Thus in preparing a patient for an operation, it is inadvisable to keep the urine absolutely sugar-free and the blood-sugar should be maintained at about 180 mg. per cent. If the patient has not already been taking insulin, the process of stabilisation may take a week or more and this can only be done effectively in the case of "set" operations. In an emergency there is usually time at least to render the urine ketone-free, and apart from such urgent operations as for hæmorrhage and respiratory obstruction, where moments are precious, an attempt should always be made to do so.

It is usually possible to control a diabetic undergoing an operation better with soluble than with zinc protamine insulin, and if he has been taking the latter it should be replaced by soluble insulin. About three hours before operation he should be given one and a half to two times the number of units he is used to taking and this should be followed immediately by a glucose drink, containing at least two grams of glucose to each unit of insulin. Post-operatively the patient should continue on soluble insulin which should be given in smaller but more frequent doses than normally. Thus he may take four or five doses a day instead of the usual two. After the operation the blood-sugar is estimated each day for four days and every specimen of urine is tested for sugar and ketones. In testing for ketones the Rothera test should be used, as the giving of salicylates such as aspirin or Veganin may produce confusion if the ferric chloride test is relied on. Reliance should not be placed on the urinary sugar alone when blood-sugar estimations are possible and the results immediately available, because an operation is liable to upset the function of the kidneys and the bladder may not be completely emptied, so that the samples may be misleading and may represent urine secreted from the kidneys twenty-four or more hours before. If reliance is perforce placed on urinary investigations alone, then care should be taken to see that the bladder is emptied satisfactorily, if necessary by catheterisation. Even this precaution does not overcome the difficulty that an operation may lower the renal threshold, so that sugar is excreted in the urine when the blood-sugar is low and insulin dosage based on urinary estimation may cause hypoglycæmia. Finally, as soon as the urine becomes sugar-free it is only by blood-sugar estimation that the proper balance can be maintained. Insulin dosage is regulated so as to maintain a slight hyperglycæmia (180–190 mg. per cent.). It is unnecessary and even dangerous to render the urine sugar-free for the first three days

Droplet Infection.—The throats of about 10 per cent. of adults normally harbour *Streptococcus pyogenes*, and about 35 per cent. of the adult population are nasal carriers of *Staphylococcus aureus*. These facts make it necessary to protect a wound, while it is being dressed, from droplets carried in the breath of the dressers. Accordingly an efficient mask must be worn. This may consist of Cellophane or of numbers of layers of material, but is best made of linen in the form of a bag, four inches by eight inches, with tapes at the four corners. A piece of newspaper is inserted into the bag and makes the mask impermeable to droplets.

The Fingers of the Dresser.—The inner dressings must never be touched by hand. Some authorities claim that the dresser should be socially but not surgically clean so that the temptation to touch the inner dressings with the fingers will be resisted. Certainly the hands should be dry and it is far better to have clean, dry hands than "sterile" wet ones.

The Air in the Ward.—Dressings should never be performed within an hour of bed-making. All windows and doors must be closed to prevent draughts which stir up the dust, and the bed-clothes and blankets of the patient should be removed with care to avoid flinging a myriad particles of clothes-dust into the air which will subsequently settle on the wound. Some institutions treat the ward floor with spindle oil to minimise dust, and experiments are being conducted with bed-clothes very lightly treated with paraffin for the same purpose.

Various methods are employed for keeping the dressing in position. The old-fashioned "many-tail" bandage is unsatisfactory because it is inclined to ride up or down, and after an abdominal operation causes a restriction of respiratory excursions which is a potent source of post-operative pulmonary complications It is, however, of great value in breast wounds where a strap over the shoulder prevents it from pulling down, and where chest complications are exceptional. A better method is to use one or more pieces of strapping applied at right-angles to the incision on either side of the wound. Tape is threaded through a hole in the strapping at the end nearest the wound and this is tied across the dressings to its corresponding fellow on the other side.

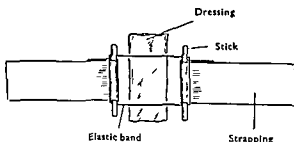


FIG 2.—The strapping, stick and elastic-band dressing

CHAPTER II

OPERATION WOUNDS, SCARS AND BURNS

I. CLEAN WOUNDS

CLEAN wounds are sutured with non-absorbable material such as silkworm gut or are clipped with Michel clips. A sterile dressing is applied and held in place by means of bandages or adhesive strapping. If the wound is comfortable and there is no reason to suspect inflammation, then it is mischievous to disturb the dressings until such time as drainage tubes have to be moved or removed and the clips or stitches taken out. Drainage tubes are used after clean operations such as mastectomy or thyroidectomy to allow blood, which oozes from the large vascular areas exposed at operation, to escape on to the surface and so prevent the formation of a hæmatoma. Drainage tubes used for this purpose may be completely removed after forty-eight or seventy-two hours. By this time oozing should have stopped and to leave them longer invites sepsis.

The Technique of Wound Dressing

Under modern conditions infection of a wound in the theatre is an exceptionally rare accident. A proportion of operation wounds, varying between 2 per cent. and 30 per cent. in different circumstances, do subsequently become infected due to contamination after the operation. These infections are, for the most part, not serious, but they frequently delay healing, may give rise to an unsightly or painful scar and are occasionally attended by the gravest consequences. It is therefore necessary to adopt a technique of wound dressing which will reduce this infection to the minimum. The whole question is dealt with in great detail by McKissock, Wright and Miles (*Brit. Med. J.*, 1941, 2, 375), and in a leading article in the *Lancet* (*Lancet*, 1941, 2, 565), to which the reader is referred.

The main sources of infection are from the breath of the dresser, from the hands of the dresser and from air in the ward. We will deal with these three sources of infection separately, and from such a consideration a technique of dressing will evolve. To adopt the full ritual described in the articles cited above demands a staff which is likely to be available only in a large institution, and the following will describe those principles which can be put into practice anywhere.

threaded through rubber tubes to minimise their tendency to cut through the flesh and they are usually left with their ends cut longer than the skin sutures. Deep-tension sutures can generally be taken out on the tenth or twelfth day, but can be left longer if they are still serving a useful purpose in holding the wound together.

Hæmatoma

Should a hæmatoma develop, then this must be evacuated without delay. With the strictest aseptic precautions the incision is carefully opened over the site of the hæmatoma. This can be done conveniently with a pair of sharp-pointed scissors. The points of the closed scissors are insinuated carefully between the lips of the wound and are then gently opened in its long axis. The hæmatoma may escape under tension or a little pressure may be exerted on the skin alongside and it will then be readily expressed. This manœuvre must be practised before the clot organises and it is practically painless.

Infection Arising in a Clean Wound

If a wound becomes infected, then it will be painful or throbbing, undue tenderness will be experienced on applying pressure through the dressings and, without removing these, redness or swelling may be observable in the uncovered areas around. In addition, the temperature and pulse-rate will usually be elevated to a greater degree than is natural as a result of healing by first intention. The appearance of these symptoms and signs is an indication to remove the dressings and examine the wound. If the sepsis has arisen deeply in the wound, then by the time it produces the above symptoms there will be considerable swelling and tension in the part. The skin-temperature will be raised, the wound edges red and angry and the stitches tending to cut out. In these circumstances one or more stitches should be removed and the wound allowed to gape. If *pus* has formed and does not readily escape on removal of some of the stitches, then it may be necessary to explore the part with sinus forceps under an anæsthetic and insert a drainage tube. If the sepsis is superficial, or if on removal of stitches *serous material* escapes and there is no reason to suppose that pus is present, then there is no need to explore the wound further, but a culture should be made to determine the infecting organism. Four-hourly dressings with Antiphlogistine should be applied and over these may be placed a pad heated by an electric coil if this is available.

The local application of heat hastens the onset of suppuration if

Messrs. Thackray supply a ready-made corset under the name of "Pressoplast lace-dressing", and this, although more expensive than the home-made variety, is probably the best. A very good dressing for a small wound is the "strapping, stick and elastic-band" method shown in Fig. 2. Wherever strapping is applied to the skin the latter should be dabbed with *Tinct. Benzoin. Co.* beforehand to minimise the irritation.

In cases where there is a long incision, such as after radical mastectomy or nephrectomy, or where for any other reason such as sepsis there is a possibility that healing of the wound may be unsatisfactory, *ascorbic acid* should be given in doses of 50 mg. (2 tablets) twice a day. Experimentally this substance has been shown to have an accelerating effect on the healing of wounds.

Clips and Stitches

If Michel clips have been used, half of these may be removed on the fourth post-operative day and the remainder on the fifth. Some surgeons may require that the clips should be removed sooner than this if the scar is in a situation where it will be visible and if there is no tension. Stitches should in general be removed on the sixth and seventh days, but there are exceptions to this rule. If very fine silk or thread has been used for sewing up wounds of the face, then the wound may have been left uncovered and the stitches should if possible be removed on the third and fourth days. Occasionally, if there is no tension, it will be possible to remove all such sutures on the third day. By such means the cosmetic effect is enhanced. After the stitches have been removed the scar may be covered with a thin strip of gauze soaked in collodion or the gauze may be dispensed with and collodion dabbed directly on the wound. This acts as a splint and prevents widening of the scar. In ten days' time the facial scar should be massaged gently with the finger, using a lanoline cream so that the skin becomes supple and the scar is freed from adhesions. If there is a tendency to keloid formation, radiation in the form of X-ray or the superficial application of radium needles is indicated, and this treatment is called for both before and after the operation for removal of a keloid scar (p 51). Subcuticular wires and stitches are removed on the fourth or fifth day. After most abdominal operations, after radical mastectomy and after any operation where it is necessary to exert traction to bring the skin into apposition, tension-relieving silkworm gut sutures will have been inserted in addition to the skin sutures or clips. These sutures are distinguished by the fact that they take a wider bite of the tissues than do the skin sutures, they are frequently

peutics. At the time of writing a solution of the sodium salt is employed both parenterally and locally; whilst the calcium salt is made up with Sulphathiazole powder for local insufflation, so that there are 5,000 units of penicillin (*vide infra*) per gram (*Penicillin-Sulphathiazole powder*).

Pure penicillin has not been isolated and its chemical composition is not known; its synthesis, therefore, remains only a theoretical possibility and all samples are derived by a laborious and expensive process from the natural mould. Its anti-bacterial capacity is so great that dilutions of at least 1 : 50,000,000 will completely inhibit the growth of many pathogenic organisms. From the evidence we have, penicillin is not bacteriocidal but bacteriostatic; that is, its action is to inhibit the division and multiplication of bacteria only, so that susceptible organisms may retain their pathogenicity even in high concentrations of the drug. Penicillin holds the organisms in check, however, until the defences of the body can be mustered and mobilised to exterminate them. A sufficiently high concentration must therefore be maintained at the site of invasion for a period long enough to allow the body defences to be effective. A falling off in the concentration of the drug before this object has been achieved will at once allow the remaining bacteria to multiply, and the infection will gain the upper hand. Dosage of penicillin must be regulated with this picture in mind. The " unit " of penicillin is purely empirical, and the number of units in a sample is measured by comparing the anti-bacterial strength of the preparation with a standard preparation kept at Oxford, or with daughter standards kept in different parts of the world. The number of units contained in a given weight of the substance therefore varies with the purity of the sample. As a course of penicillin may involve the use of more than a million units and in order to facilitate the ordering of this substance in bulk without resource to the ambiguous term " billion " or the use of a string of noughts, the *Mega unit*, equal to a million *Oxford units*, has been recognised by British and United States authorities. Where the type of unit is not specified the Oxford unit is understood.

Penicillin is dispensed as a powder or tablet in which form it is fairly stable, but should nevertheless be stored in a refrigerator. British sources at present supply the sodium salt in tablets of 7,500 units each. American manufacturers put it up as a powder in ampoules containing 100,000 units. An effective concentration is obtained by the intramuscular injection of 15,000 units every three hours or, mixed with saline, plasma or blood, by intravenous drip infusion of 120,000 units over a period of twenty-four hours. Before adminis-

suppuration is inevitable, but will not cause suppuration to occur in a wound which would otherwise resolve. In such wounds the resolution is accelerated by the local application of dry heat and indeed it is not unreasonable to suppose that some wounds which would otherwise have suppurated are encouraged to resolve by this means. The old-fashioned hot boracic fomentation may have led to suppuration because the tissues underneath become soggy and poorly resistant to infection. The patient should be confined to bed and given fluids freely. If the wound is in a limb, a splint should be applied to secure absolute rest. As the infecting organism is usually the streptococcus, a course of parenteral penicillin is prescribed.

Penicillin

In the years following 1939 the British nation rose to new heights of courage and endurance, leading the world in the struggle to establish the rule of justice. Amidst the clamour of these great achievements, but deserving to rank with them and with consequences equally as profound and beneficial, British Medicine gave to the world—penicillin, perhaps the greatest therapeutic agent of all time.

In 1929 Professor Alexander Fleming, of St. Mary's Hospital, Paddington, discovered that the mould *Penicillium notatum* inhibited the growth of many pathogenic organisms. In 1940 a more or less stable active principle was obtained from this mould and from that time, largely due to the brilliant work of Professor H. W. Florey of the William Dunn School of Pathology, Oxford, penicillin (as the active principle came to be called) was manufactured with ever-increasing purity and in rapidly expanding quantities so that it is now readily obtainable for therapeutic use.

The effect of this extraordinary substance on therapeutics has been revolutionary. It will not be possible here to write fully of its properties or its value, but a brief outline must be given so that the practitioner may use it effectively and intelligently. When a new substance of startling potency is introduced it takes many years for the technique of its administration to become standardised, its limitations understood and its disadvantages appreciated. Consequently the details of dosage and indications for its use which are described here may well be subject to modifications as the years (or even the months) go by, but it is unlikely that the principles will change and it is hoped that the ensuing account will be of more than ephemeral value in its emphasis of these.

Penicillin is an acid, but as in that form it very rapidly breaks down, the relatively stable sodium and calcium salts are used in thera-

Gonococcus
Claustridia Welchii, œdematiens, septique
Bacillus anthracis
Bacillus diphtheriæ
Trepanoma pallida

ORGANISMS INSENSITIVE TO PENICILLIN

Bacillus pyocyaneus
Bacillus proteus
Bacillus coli communis
Bacillus typhosus and *paratyphosus*
Streptococcus fæcalis
Some strains of *Streptococcus viridans*
Occasional strains of *Staphylococcus aureus*

Penicillin may be made into a cream for application to superficial skin lesions by mixing a solution into a base of 30 per cent. Lanette Wax and 70 per cent. sterile water so that the ointment contains 400 units per gram. This substance remains fairly stable at room-temperature, but is better stored in a refrigerator, and retains its potency for about two months. Penicillin-Sulphathiazole powder (*vide supra*) is also used for insufflation on to raw surfaces. The use of penicillin in solution as a local application to infected and potentially infected wounds is so bound up with the problem of wound suture, which is an integral part of the technique, that it will be described under that heading (page 34). Solutions of penicillin do not pass readily from the blood-stream into joints, the pleural cavity, the peritoneal cavity or the cerebrospinal-fluid space. If these sites require penicillin, some form of local treatment is used and this will be discussed in the appropriate section. For practical purposes harmful reactions to penicillin, apart from occasional urticaria, can be said not to exist. Disadvantages to its use are the discomfort and pain of intramuscular injection, and the phlebitis which sometimes follows prolonged intravenous therapy. The production of penicillin may, however, become so inexpensive that it will be practicable to give enormous doses by mouth, or the drug may be protected by capsules, so that sufficient penicillin escapes destruction by the gastric juices and an adequate blood-concentration is attained by intestinal absorption.

The Sulphonamides

Penicillin has largely usurped the place of the sulphonamides in the realm of therapy. In theory the sulphonamides are indicated

tration the powder or tablets are dissolved in sterile water or saline, and once in solution the substance becomes extremely unstable and must be kept in a refrigerator. At room-temperature the solution loses its potency in a few hours so that, after a dose has been withdrawn from the stock solution, the remainder must be returned at once to the refrigerator where it will keep for two days. The ideal concentration of solution to be injected intramuscularly has not been settled, but there is a tendency to regard the strength of solution used hitherto as too dilute and a smaller bulk of material injected is found to be less painful. Present-day opinion inclines to the view that the 15,000 units are suitably contained in 1·5 c.cm. of sterile water so that the British tablets are dissolved in the proportion of four tablets (of 7,500 units each) to 3 c.cm. of water and the contents of an American ampoule (of 100,000 units) are dissolved in 10 c.cm. of sterile water. A course of parenteral penicillin thus consists in the intramuscular injection every three hours of 1·5 c.cm. of one of the above solutions.

A course usually lasts from 3 to 5 days or longer if the general or local symptoms of infection persist. It is, however, usually fruitless to continue after a total of one and a half *Mega* units has been given. The instability of the solution and the readiness with which it is destroyed by alcohol, antiseptics and penicillin-resistant organisms demand a special technique for injection. The skin must be cleaned with soap and water or Cetavlon ; spirit, iodine, picric acid and other antiseptics should not be used. Syringes and other apparatus used in making the solution must be sterilised by heat and stored dry, and the process of dissolving the powder or tablets is conducted with full aseptic ritual. The three-hourly injections are liable to be painful, but the discomfort can be alleviated by mixing Procaine with the solution, to make a strength of 1 per cent. of local anæsthetic, *immediately before injection.* This mixture is unstable and should not be kept. Other preparations of cocaine destroy the penicillin and cannot be used for this purpose

The following table shows the effect of penicillin on organisms commonly encountered in clinical medicine.

ORGANISMS SENSITIVE TO PENICILLIN

Streptococcus pyogenes
Streptococcus viridans (most strains)
Staphylococcus albus
Staphylococcus aureus (except 5 per cent. resistant strains)
Pneumococcus
Meningococcus

	INDICATIONS	DISADVANTAGES
SULPHAGUANIDINE AND SUCCINYL SULPHATHIAZOLE	Bacillary dysentery (prescribed in large doses). Only slightly absorbed from the intestines	

A course of sulphonamide therapy consists in giving three tablets (of half a gram each) at once and two tablets every four hours for the next forty-eight hours. After this time the dose is reduced to one tablet every four hours, and this dosage is continued for at least four days or until the infection is overcome. Fifteen grains of potassium citrate are given before each dose to help to alleviate nausea and vomiting, and to render the urine alkaline. Increasing cyanosis, vomiting or other evidences of intolerance indicate that the drug must be withheld. Whilst the drug is being given the patient must be confined to bed and fluids must be given freely, otherwise deposits of crystals may form in the pelvis of the kidneys and in the ureters, leading to hæmaturia or anuria, sometimes with fatal results. The kidneys must be made to excrete more than 50 oz. of alkaline urine in the twenty-four hours, and to effect this at least 5 pints of fluid must be taken in the day in temperate climates, if necessary parenterally. At the first sign of hæmaturia or pain in the loin the drug must be withheld and the fluid intake pushed to the limits of tolerance. Persistence of these evidences of renal affection together with a diminishing urinary output demand immediate ureteric catheterisation to drain the urine from the pelvis of the kidney where it is dammed up by a mixture of crystals and blood-clot in the ureters. On one occasion I have found blood-clot and crystals so firmly impacted in the ureteric orifices that retrograde catheterisation was not possible, and nephrostomy was performed with a gratifying flow of clear urine from a tensely distended pelvis, followed by an uninterrupted recovery. If big doses are being used, frequent white-cell counts are necessary to forestall the earliest evidence of agranulocytosis. Exposure to natural or artificial sunlight is avoided during a course of the sulphonamide group of drugs, as reactionary skin rashes are liable to occur.

It has been found that Procaine and allied local anæsthetics neutralise the effect of the sulphonamides ; cocaine, Eucaine, Stovaine and Nupercaine, on the other hand, are without effect and should be used instead when a patient is undergoing a course of sulphonamide therapy (*Lancet*, 1943, 2, 232).

For local application, solutions and pastes have been largely

when the infection is from an organism which is penicillin-resistant. In practice, perusal of the "drug-books" for the last year of two large hundred-and-twenty-bedded surgical wards shows that the sulphonamides are prescribed in three types of case: firstly in renal and abdominal infections where the organism is often penicillin-resistant and where mechanical and physiological considerations prevail; secondly in post-operative chest complications where the encouragement of expectoration is paramount and chemotherapy is very much an ancillary measure, so that the trials of intramuscular therapy need not be inflicted on an already distressed patient; and thirdly in infections which have failed to respond to penicillin.

The available sulphonamides and their generally accepted properties are shown in the accompanying table.

	INDICATIONS	DISADVANTAGES
SULPHANILAMIDE	Effective particularly against the *streptococcus* and the *bacillus coli communis*	Skin reactions, vomiting and cyanosis not uncommon. Renal symptoms not reported
SULPHAPYRIDINE	Effective particularly against the *pneumococcus*	Vomiting and cyanosis common. Tendency to produce renal symptoms
SULPHATHIAZOLE	Wide range of activity including the *staphylococcus*	Tendency to produce skin rashes, headache and malaise. Renal symptoms and vomiting not uncommon
SULPHADIAZINE	Wide range of activity including the *staphylococcus*. Slow excretion produces high concentration in the blood	Tendency to produce renal symptoms
SULPHAMEZATHINE (SULPHAMETHAZINE)	Probably the most universally valuable. Wide range of activity including the *staphylococcus*	Produces headaches, but other symptoms very uncommon
SULPHAMERAZINE	Recently introduced	

substituted. The principle of wound drainage is to allow the cavity to granulate or to collapse from the bottom up and to ensure that no isolated pocket is left behind unobliterated. If this purpose is borne in mind the drainage tubes can be manipulated intelligently so as to secure a successful healing of the wound.

The advent of penicillin has caused a reorientation of our ideas in regard to the treatment of the infected or potentially infected wound. The views expressed here are the result of experience in the treatment of a personal series of over a thousand infected wounds, and the fruit of frequent and stimulating discussions with surgical colleagues. The vast majority of the wounds in this series were " war wounds ", but a considerable number were such as would be encountered in civil practice, and the same principles were found to apply equally to both varieties. The first important feature in the management of these cases which has emerged as a result of the experience of the last few years is that, if possible, a wound should be covered by skin. Skin is the best possible dressing for any wound ; if the skin-covering can be maintained it leads to early healing, the control of sepsis, relief of pain, prevention of protein-loss and anæmia, minimal scarring, ease of nursing and an early return of the patient to normal life. With penicillin the majority of infected or potentially infected wounds can be safely covered with skin.

In considering the infected wound, therefore, we can divide our cases into those in which there is sufficient skin available to cover the wound without " tentage " (unobliterated dead space under the sutured skin), and those in which there is insufficient skin available to cover the wound. The accompanying table outlines the indications for treatment in these classes of wounds.

A. CASES IN WHICH THERE IS SUFFICIENT SKIN AVAILABLE TO COVER THE WOUND WITHOUT " TENTAGE "

PRIMARY SUTURE.—Where surgical treatment is early ; where the nature of the wound allows reasonably complete wound toilet ; where there is only slight damage to tissue ; where the case can be held for treatment for at least a week ; and in most wounds of the face and scalp.

DELAYED PRIMARY SUTURE (suture of a wound between the second and the eighth day). In all other types of wound except those infected with gas-forming organisms.

SECONDARY SUTURE (suture of a wound after the eighth day). Where gas-forming organisms have prevailed ; where there has been neglect or incapacity to perform delayed primary suture ;

discarded in favour of powder, often combined with proflavine (*vide infra*), applied by means of a sterile insufflator or sprinkled on with a pepper-pot or scalpel so that a thin frost is produced over the wound surface.

Sulphonamide powder can be rendered free from contamination with tetanus or other spores by sterilising in bottles, using dry heat at 150° C. for some hours, and whatever preparation of sulphonamide is used locally it must be sterilised. In order to prevent over-dosage, no more than 10 grams of sulphonamide powder should be used on any one wound, and no more than 15 grams on any one patient every alternate day.

Watt and Alexander have shown (*Lancet*, 1942, **1**, 493) that the use of Sulphathiazole as a dressing for craniotomy may be followed by epileptic attacks and it is now generally recognised that this drug cannot be used with impunity in contact with the brain (*Brit. Med. J.*, 1942, **2**, 548).

II. INFECTED WOUNDS

General Considerations

When a wound is infected from the start, as after operations for abscess, then different considerations apply. In the first place clips are never used and the wound is either left unsutured or salmon-gut sutures are used partially to close the skin around drainage tubes. It is often necessary to leave these stitches in for longer than six or seven days in order to prevent the septic wound from gaping widely, and the time for removal of such stitches must be judged from this point of view. *Drainage tubes* employed in septic wounds are not removed after forty-eight hours, as when their purpose is to give egress to blood, but they must be shifted after this period. This is particularly urgent in the case of intraperitoneal drainage tubes, because if they are left undisturbed they are liable to erode the gut-wall and cause a fæcal fistula or even erode the wall of a large artery and lead to secondary hæmorrhage. If the purulent discharge is still copious after forty-eight hours the tubes should be turned on their own axis through a complete circle if they are round, or withdrawn half an inch and then replaced the same distance if they are of corrugated rubber; but in either case they should be left as deeply embedded as before. Thereafter the drainage tubes should be shifted each twenty-four hours. As the discharge lessens the shifting can consist in partial withdrawal without replacement, so that the tubes become gradually removed altogether or in some cases they can be removed completely and a smaller drain

substituted. The principle of wound drainage is to allow the cavity to granulate or to collapse from the bottom up and to ensure that no isolated pocket is left behind unobliterated. If this purpose is borne in mind the drainage tubes can be manipulated intelligently so as to secure a successful healing of the wound.

The advent of penicillin has caused a reorientation of our ideas in regard to the treatment of the infected or potentially infected wound. The views expressed here are the result of experience in the treatment of a personal series of over a thousand infected wounds, and the fruit of frequent and stimulating discussions with surgical colleagues. The vast majority of the wounds in this series were " war wounds ", but a considerable number were such as would be encountered in civil practice, and the same principles were found to apply equally to both varieties. The first important feature in the management of these cases which has emerged as a result of the experience of the last few years is that, if possible, a wound should be covered by skin. Skin is the best possible dressing for any wound ; if the skin-covering can be maintained it leads to early healing, the control of sepsis, relief of pain, prevention of protein-loss and anæmia, minimal scarring, ease of nursing and an early return of the patient to normal life. With penicillin the majority of infected or potentially infected wounds can be safely covered with skin.

In considering the infected wound, therefore, we can divide our cases into those in which there is sufficient skin available to cover the wound without " tentage " (unobliterated dead space under the sutured skin), and those in which there is insufficient skin available to cover the wound. The accompanying table outlines the indications for treatment in these classes of wounds.

A. Cases in which there is Sufficient Skin Available to Cover the Wound Without " Tentage "

Primary Suture.—Where surgical treatment is early ; where the nature of the wound allows reasonably complete wound toilet ; where there is only slight damage to tissue ; where the case can be held for treatment for at least a week ; and in most wounds of the face and scalp.

Delayed Primary Suture (suture of a wound between the second and the eighth day). In all other types of wound except those infected with gas-forming organisms.

Secondary Suture (suture of a wound after the eighth day). Where gas-forming organisms have prevailed ; where there has been neglect or incapacity to perform delayed primary suture ;

and in the rare cases where delayed primary suture has broken down.

B. CASES IN WHICH THERE IS INSUFFICIENT SKIN TO COVER THE WOUND OR WHERE SKIN SUTURE WOULD PRODUCE "TENTAGE"

SKIN-GRAFTS (or skin-grafting plus suture). Whenever possible.

PLASTER.—Where the floor of the wound is composed of tissues such as bone, cartilage, tendon, fibrous tissue and large vessels or nerves which need to be covered by granulation tissue before they can satisfactorily accommodate a skin-graft.

CARREL-DAKIN'S TUBES.—Where deep pockets require flushing.

MAGGOTS.—Where masses of necrotic tissue require scavenging.

Wounds with Sufficient Available Skin

PRIMARY SUTURE

This measure, which entails the performance of wound toilet, is a subject not within the scope of this book, and reference should be made to a text-book of Operative Surgery for a description of the details of the technique. Local penicillin should be used, and the principles of penicillin therapy in this type of case are precisely similar to those which will be described in the following section.

DELAYED PRIMARY SUTURE

This method, which is here defined as the suture of wounds between the second and eighth day after they have been sustained, is the treatment of choice and is practised in every case unless contra-indicated. The contra-indications to delayed primary suture are *insufficient skin* and *anaerobic interstitial cellulitis* or *gas gangrene.* Other forms of sepsis, apart from the very rare persistent acute inflammation, are not considered contra-indications. With the help of penicillin, either in powder form or solution, the vast majority of wounds which have been treated according to established principles can be sutured after seventy-two hours. If there is any doubt, then it is worth while suturing the wound, as no case which has been sutured will suffer from that step, and the worst that can happen is that the suture will be a failure. The best time for delayed primary suture is on the third or fourth day after wounding. Every day after the fourth the wound becomes less easy to suture. Granulation tissue causes the skin edges to curl under and become friable, and the œdema

underlying the granulations makes it progressively more difficult to bring the deep surfaces into apposition without tension. On the third or fourth day, therefore, the wound is examined in the operating theatre. In the vast majority of cases it will be found fit for delayed primary suture. If this is so, the patient is anæsthetised, usually with Pentothal, and the first step is a gentle examination of the wound with the finger in order to determine its extent, to open up deep ramifications and to palpate for foreign bodies which, if they are readily accessible or causing symptoms, are removed. A little time spent in localising and removing a foreign body at this stage may save the patient from the consequences of chronic suppuration later. The skin wound is then elongated with the scalpel by a centimetre at both ends. A strip of skin about two millimetres wide is excised from the wound edges with a pair of scissors, starting at one scalpel cut and ending at the other on each side. Gentle freeing of the skin edges from the underlying tissue with the finger or the scalpel for a distance of a centimetre or two facilitates accurate apposition subsequently. If skin is lacking, more undercutting is permissible. The extent to which skin edges may be mobilised by undercutting varies in different parts of the body and in different patients. This procedure should be reduced to a minimum in order to avoid the manufacture of potential dead space, but viability of the skin is preserved if a longitudinal wound of the thigh (and most limb-wounds are longitudinal after the first operation) is undercut by ten centimetres on each side and a similar wound of the upper arm by six. In this way considerable mobility of the skin edges is obtained. If the wound is shallow, simple and regular, penicillin-Sulphathiazole powder is insufflated over the surface and the skin is sutured with silkworm gut or Nylon (No. 3). Stitches enter and emerge from the skin half a centimetre from the wound edge and the stitches are half a centimetre apart. Tension is not a serious danger to the integrity of the suture-line. If the wound can be drawn together without jeopardy to the blood-supply it should be sutured. The use of penicillin together with firm bandaging occasions the rapid disappearance of tissue œdema, so that the tension which was apparent at operation soon subsides. The suture-line is then cleaned with gauze soaked in saline, dried and dusted with penicillin-Sulphathiazole powder. A dry dressing is applied, a pad of wool an inch in thickness is placed over this, and finally the part is firmly bandaged with flannel bandage and, if a limb, immobilised on a splint.

When the wound is deep and complex, penicillin solution (1,000 units per c.cm.) is used instead of powder. Depending upon the size

of the wound, one or more rubber tubes (two to three millimetres in internal diameter) are introduced into the wound through conveniently placed stab-holes, not less than two centimetres from the wound edge, and the inner ends of the tubes are adjusted so that the penicillin solution when injected can reach all parts of the wound. In order to obliterate dead space it may be necessary to suture deep tissues, but these sutures as well as ligatures should be cut down to a minimum. The skin edges are then sutured with silkworm gut or Nylon as before and the projecting rubber tubes secured by a stitch to the lips of the stab-holes through which they emerge. Firm dressings are applied and holes are cut in these through which the outer ends of the rubber tubes project. As a routine 2·5 c.cm. of penicillin solution are injected through each tube at the conclusion of the operation and the tube is then occluded by kinking it over gauze and strapping it to the part. Twice a day for the next five days the tube is exposed and discharges are aspirated by means of a syringe. When the wound has been sucked dry, 2·5 c.cm. of penicillin solution are introduced into each tube by means of a fresh syringe, which has been rinsed in sterile water, and the tube is occluded as before. On the sixth day no solution is run in, but aspiration of the wound may be carried out and, on the seventh day, the wound is dressed and the penicillin tubes are removed. Stitches are removed on the tenth day to the twelfth day depending upon the state of the wound. Dosage of penicillin is a matter of experience. It is necessary on the one hand to ensure that adequate amounts of solution reach all parts of the wound and, on the other, that the volume of solution is sufficiently small not to flood the suture-line and render the wound moist. In a wound, for instance, four inches long with a track burrowing deeply for four inches, two tubes would be inserted, one passing to the bottom of the track, the other lying in the superficial gutter. If the method of instillation outlined above is followed on such a wound, the six-day course will give a total dosage of 60,000 units.

When the dressing is done on the seventh day the suture-line may be moist, and exuding sero-pus due to "Gram-negative", penicillin-resistant organisms. Its appearance is an indication for dusting the wound daily with Sulphathiazole powder containing 1 per cent. proflavine ("Gram-negative powder") and covering with a dry dressing In cases of multiple wounds which are grossly septic the above procedures are combined with a routine course of parenteral penicillin beginning twenty-four hours before the operation and lasting for five days.

SECONDARY SUTURE

Secondary suture is defined as the suture of a wound after the eighth day. The indications for this measure are shown in the table on page 33. The crucial decision is whether there is sufficient skin to come together after the wound has been excised and the edges undercut. The simple methods of pinching up the skin on either side of the wound to judge of its elasticity and mobility, coupled with previous experience, are the only reliable guides on this point. Here the incurled edges and the œdematous fibrosis underlying the wound surface demand a more elaborate procedure than the simple excision of skin edges which is all that is necessary in most cases of delayed suture. The skin edges after the eighth day will not only require " freshening ", but will have to be undercut to a greater or less degree to allow of their approximation, bearing in mind the limitations of this measure outlined above. In addition the granulations lining the wound surface are excised, if possible in one piece.

Penicillin-Sulphathiazole powder and penicillin solution are used in secondary suture in the same way as was described for delayed primary suture, and the use of these agents has rendered septic wounds amenable to treatment by this method which would hitherto have been left to heal by slow spontaneous epithelialisation. Where excision of the septic tissue would have to be so extensive as to leave dead space in the depths (" tentage "), as is particularly likely to happen in the region of the great trochanter of the femur and the anterior superior spines of the pelvis, or where it would lead to skin inadequacy on the surface, the wound may be partially sutured and the remainder grafted at the same time or at a later date.

Wounds with Insufficient Available Skin

SKIN-GRAFTS

We come now to the treatment of those cases in which there is not sufficient skin to perform suture. Acting on the principle that the wound must be covered by skin if possible, such cases are commonly skin-grafted. With the advent of penicillin, most cases are suitable for grafting unless sepsis is severe as indicated by red, tender wound edges, copious discharge, adherent sloughs or films of thick pus clinging to the wound surface. Where sepsis of this degree contra-indicates grafting, the wound is treated by four-hourly compresses of Eusol until the above signs have disappeared. Where the wound is bordered by unhealthy skin and lined by dirty granulations it may be advisable to excise the skin and scrape the granulations. The application of penicillin powder and dry gauze to the resultant wound will produce

an ideal surface for grafting in four days. Sepsis due to a foreign body or osteitis may modify the procedure, and grafting may have to be confined to that part of the granulating surface free from gross contamination or flooding by the discharging sinus. The old conception that in order to graft a granulating surface it had to be flat, pink and painless now no longer obtains.

Preparation of the granulating surface for grafting consists in applying a dressing of Eusol for three days prior to the operation and compressing with a firm bandage. The dressings are kept moist by a covering of jaconet so that the granulations are not torn as when a dry dressing is removed, and these dressings are changed four-hourly during the day time. Just before the graft is applied the granulating surface may be lightly " frosted " with penicillin-Sulphathiazole powder. The type of graft to be used and the technique of the operation are subjects which are the concern of the operating surgeon. After the grafts have been placed on the granulating surface, the area is covered with *tulle gras*. Gauze, richly soaked in " flavine-paraffin emulsion ", is applied so cut and folded that every irregularity on the wound surface is closely packed. Dry gauze is then laid on and followed by a layer of wool one inch thick. The part is firmly bound with elastic bandage, and if possible, splinted. On the fifth day, whatever kind of graft has been used, the wound is dressed, discharges removed and dead skin carefully cut away with scissors. Dressings are reapplied as before and this process is repeated every day until the tenth by which time, in a successful case, the area is practically healed. When, after the fifth day there is found to be copious discharge from areas where the graft has not taken, the part is dressed with " Gram-negative powder " (*vide supra*) or, if there is evidence of infection with the staphylococcus or streptococcus, penicillin-Sulphathiazole powder is used.

PLASTER

The indications for this method of treatment are given in the table on page 34 ; it is used essentially where the floor of the wound is unsuitable for grafting. The wound is frosted with penicillin-Sulphathiazole powder, Vaseline gauze is laid gently into the cavity, and the whole part is immobilised in plaster A "window" should not be cut in the plaster over the wound. The essence of the treatment is to leave the wound undisturbed for long periods with equal pressure all round the limb. In these circumstances a watch is kept on the temperature and pulse-rate, which will rise if there is any deep infection which is not draining freely to the surface. In such cases the wound will be painful

and there may be œdema and deficient circulation in the exposed parts distal to the plaster. Such signs are an indication for removal of the plaster and inspection of the wound. If the part is comfortable and practically painless, the plaster should be left on for two weeks or until the discharge becomes so offensive and the plaster so macerated that it is necessary to put on a fresh one. The limb is immobilised in this way until healthy granulations have formed, when the wound can be prepared for skin-grafting by the application of Eusol compresses. The chief drawback to this method is the *smell*. If possible the patient should be nursed in the open air on a balcony and the application of boracic crystals or of yeast, which can be bandaged on to the outside of the plaster cast, may help to control this nuisance. Recently special deodorising bags made of "*filter-cloth*" have been devised into which the whole limb can be placed and these may prove the solution to this problem. The "filter-cloth" is made into a loose-fitting bag which completely encases the plaster. It must not be applied until four days after the plaster has been put on because during this time it is necessary to have the extremities exposed for inspection. The deodorising properties of the bag will last for two to five weeks, depending on the nature of the case. The fitting of the bag should be particularly loose at the extremities to permit exercise of these while the plaster is on. If a "filter-cloth" is not available, perhaps the next best way of controlling the smell is to treat the outside of the plaster with an equal mixture of sulphonamide powder and lactose. The former helps to inhibit bacterial growth and the latter is utilised in preference to protein by the proteolytic organisms which are responsible for the smell. The degree of protein autolysis is therefore reduced and the relatively odourless decomposition of lactose takes its place.

Carrel-Dakin's Tubes

If Carrel-Dakin's tubes are used they are connected by means of a *manifold* to a flask containing Dakin's solution. This connection should not be through a glass drip-apparatus but should be direct. The flask containing the Dakin's solution is suspended so as to deliver the fluid at three feet head of pressure. Delivery through the Dakin's tubes is intermittent under full pressure. By this means all the perforations in the tubes are flushed through and the solution reaches every part of the wound. The amount of fluid delivered depends upon the number of tubes in use and half an ounce should be delivered from each tube. Thus, if there are four tubes, 2 ounces of Dakin's solution are flushed through with each delivery. This should be repeated every two hours, night and day, until the general and local signs indicate that

an ideal surface for grafting in four days. Sepsis due to a foreign body or osteitis may modify the procedure, and grafting may have to be confined to that part of the granulating surface free from gross contamination or flooding by the discharging sinus. The old conception that in order to graft a granulating surface it had to be flat, pink and painless now no longer obtains.

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granulations readily become suitable for skin-grafting. The method is applicable to the treatment of third-degree burns (p. 56).

MAGGOTS

Finally there is the method of treating suppurating wounds with maggots. This is a method which does not appeal to many surgeons because of the unpleasantness of the idea and also because of the practical difficulties of culturing sterile maggots and confining them to the wound. A full account of the technique of maggot therapy will be found in *Surgery of Modern Warfare*, Section II, edited by Hamilton Bailey. Often, however, a wound is found accidentally contaminated by maggots and it is necessary to know how to deal with them. Maggots in a wound are on the whole beneficial, in that they feed only on dead and necrotic tissue, leaving healthy granulations severely alone. On the other hand, after they are fully grown (a process which takes about seventy-two hours) they are of no further value and should be removed. This is sometimes difficult, but the surest method is to pour chloroform over them to kill them and then to remove the dead bodies with forceps.

Specific Infections

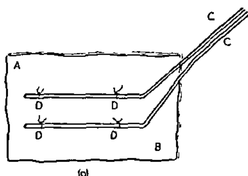
Whenever possible a septic wound should be cultured in order to determine the organisms involved. The flora of an infected wound is generally mixed. *Streptococci* and *staphylococci* of varying degrees of pathogenicity are often encountered, but if the infection is chronic or subacute and there is pus formation, then the appearance of these organisms in the culture does not call for the use of penicillin or the sulphonamide group of drugs. There are, however, certain organisms which if cultured from a wound demand that the specific antidote be applied.

GAS-FORMING ANAEROBES

First let us consider the gas-forming anaerobes, *Clostridium Welchii*, *Cl. septique* and *Cl. œdematiens*. The recovery of these organisms in culture does not necessarily indicate gas gangrene and, unless the wound is one involving much destruction of muscle or where the blood-supply is precarious, gas gangrene need not be anticipated. Where these two factors obtain, however, or where one of the gas-forming anaerobes has been recovered on culture, then vigorous prophylaxis should be undertaken to prevent the occurrence of gas gangrene. A full parenteral course of penicillin should be instituted as described above and, as there is evidence that anti-gas-gangrene serum enhances the effect of penicillin in combating infection with these organisms (*Lancet*,

the infection has been overcome and the tubes may then be removed. A continuous trickle of solution through the tubes is useless, as all the solution escapes through the largest or nearest hole and the wound is not properly flushed. If a large wad of cotton-wool well fluffed out is placed over the dressing and if the area is left exposed to the air it will be found that, with the prescribed half an ounce per tube, all the excess solution will be absorbed by the wool and will have evaporated before the next delivery is due in two hours' time. Consequently frequent changes of dressing are not necessary and are called for only when the wool becomes dirty or smelly.

A method of treating large granulating surfaces by means of Carrel-Dakin's tubes is described by Edmunds (*Lancet*, 1941, **2**, 130). Here the purpose of the treatment is not to flush the wound, which is a flat one and draining freely, but to keep the dressings moist. The following description is taken from his article. Two thin pads of gauze (A–B, Fig. 3, *a* and *b*) are required, about six layers thick, and some Carrel-Dakin's tubes (C, C). These tubes are laid on one of the gauze pads so as to divide the surface of the pad into approximately equal parts. Each is fastened in place by two sutures (D, D). The other pad is then laid over the tubes and the two pads are tacked together round the edge, allowing the tubes to project at one corner (Fig. 3*b*). The pad is then *sterilised*.



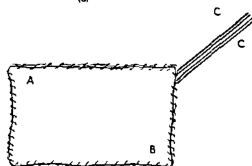


Fig. 3.—Edmunds' pads

In applying these pads, the wound is first covered with a layer of *tulle gras*. The pad is then soaked in normal or hypertonic saline and laid over the *tulle gras*, being covered in its turn by a piece of jaconet. The dressing is completed by a layer of wool especially arranged around the jaconet and a bandage through which the tubes project. The gauze is then kept moist by injecting an ounce of *saline down each tube every* six hours. Usually the pads require changing at least every three days, but the *tulle gras* may be left in place. By these means the

the above but the toxæmia is acute, the pulse rapid and thready and the patient is critically ill. The proteolysis in muscle gives rise to the typical musty smell which is characteristic of the condition, and this, together with the increased toxicity and painful nature of the lesion, serves to distinguish it from the preceding benign form. X-rays are of no value in differentiating these two types, as gas shows up in the tissue planes in each. Infection with *Cl. œdematiens* may give a somewhat different picture. Production of gas is minimal and the smell is not a noticeable feature. Diagnosis depends upon the toxic state of the patient together with the swollen, painful muscles, which later become pale and slimy, and finally purple and deliquescent. Chemotherapy and serotherapy are instituted as described in the treatment of anaerobic cellulitis, but the surgeon will have to explore the affected part to decide between excision of muscles and amputation. The prognosis in established muscle gangrene is poor and the life of the patient can only be saved by timely and radical surgery.

Anaerobic Streptococcal Myositis

Closely allied to gas gangrene clinically is the somewhat rare condition of anaerobic streptococcal myositis. In streptococcal myositis, however, there is well-marked skin erythema and the muscles, which are alive and react to stimuli, are copper-coloured. The smell is not so sickly as in gas gangrene, and bacteriological assay of the wound shows a predominance of *anaerobic streptococci*, although *Strep. pyogenes*, *Staph. aureus* and the *Clostridia* may be recovered as well. Treatment requires full doses of sulphonamide locally and by the mouth combined with conservative surgery. Radical excision of muscle in this condition is followed by a severe flare-up and must be avoided. It is for this reason that the condition should be distinguished from gas gangrene. Penicillin should be extremely effective in streptococcal myositis, but reports on its efficacy in practice are not yet available.

Diphtheroids

Occasionally in a wound which refuses to heal the *Klebs-Loeffler bacillus* or diphtheroids may be recovered in culture. Diphtheria anti-toxin is given together with a course of parenteral penicillin, but a diathermy excision of the wound edge may be necessary before the healing can take place.

Cutaneous Gangrene

There is in addition a peculiar form of spreading gangrene of the skin often starting in the wound of a discharging appendix abscess or

1945, 1, 395), 24,000 units of polyvalent anti-gas-gangrene serum are injected intramuscularly, a further 8,000 units being given daily for four days. Qvist (*Brit. Med. J.*, 1941, **2**, 217) points out that infection with the gas-forming anaerobes takes three forms, but it must be realised that one form may very rapidly run on into another.

Saprophytic.—Gas-forming organisms, as indicated above, can often be cultured from wounds and yet there is no toxæmia or the formation of gas. If the prophylactic measures described are instituted at this stage, together with the normal surgical procedures which the state of the wound demands, no spread of the infection from the surface of the wound may be anticipated.

Anaerobic Cellulitis.—Here the anaerobic organisms have spread into the cellular tissue planes and have set up an infection with the production of gas which may be detected by crepitation on palpation. Pressure with the stethoscope will also elicit crepitation on auscultation, and this is a more delicate and accurate method of assessing the degree of spread of the gas. The wound will be puffy and brick-red granulations may be visible. Bubbles of gas may exude and in the vicinity of the wound the skin may have a bruised appearance or may exhibit a patchy gangrene. The presence of gas can be confirmed by an X-ray photograph. In this type of infection toxæmia is not usually severe, but the pulse-rate is raised and there is some general malaise. Important points to notice, and the only reliable features which distinguish this type of anaerobic infection from the next to be described, are the absence of the typical musty, " mouse-like " smell and the relative freedom from pain.

This form of cellulitis calls for immediate surgical interference. Usually all that is required is to lay open the infected tissue planes and to irrigate by means of Carrel-Dakin's tubes or to treat with local applications of penicillin-Sulphathiazole powder. Penicillin is given parenterally in full doses, and at least 60,000 units of polyvalent anti-gas-gangrene serum are injected intravenously. Further injections of the monovalent serum are given intravenously on succeeding days as soon as the specific anaerobe has been cultured. Twenty-four thousand units of the specific anti-serum is a satisfactory daily dose for an established case, and this is persisted with until the infection is overcome. The prognosis in this type of infection is excellent in regard to both limb and life, and the successes reported after some unusual methods of treatment may well have been due to failure to recognise this relatively benign syndrome.

Gas Gangrene of Muscle.—In this type of infection the organism has penetrated into muscle. The local signs and symptoms are similar to

may be catgut or wool. It may occasionally appear after quite trivial wounds and has followed second-degree burns. The position in regard to giving anti-tetanic serum is as follows: if tetanus complicates an accidental wound and anti-tetanic serum has not been given, the doctor is held responsible. It is obviously impracticable to give anti-tetanic serum to every patient with a trivial wound and the doctor must judge when he is prepared to accept the responsibility of withholding serum. If tetanus develops after a surgical wound the doctor is not held responsible.

The symptoms of tetanus may come on at any time up to four weeks after sustaining the injury or undergoing the operation. On the whole the earlier the appearance of the symptoms the more severe is the attack and, although it is not a very reliable index, it is often held that if the incubation period is less than nine days the prognosis is bad, if greater than nine days the prognosis is good. A more reliable guide to prognosis is the time between the appearance of the first symptoms and the appearance of the first spasm. If this is under forty-eight hours it indicates a bad prognosis, if after forty-eight hours the longer the interval the better the prognosis.

Tetanus commonly first shows itself as a stiffness of the muscles around the jaw and in the back of the neck, often leading to the well-recognised *risus sardonicus*. Later the back muscles become tonically rigid and the back is arched, the abdominal wall is rigid and finally the limbs become stiff. Occasionally there may be difficulty in swallowing. The order in which these symptoms come on is variable and sometimes the tonicity is confined to the region wounded and may never affect the muscles of the jaw and neck. This prodromal period is usually free from pain and it is this feature of the clinical picture which serves to distinguish tetanus from other conditions producing a regional tonicity most of which, such as peritonsillar abscess, peritonitis and diphtheria, are inflammatory and painful. After a variable interval the spasms appear and usually affect the musculature over the whole of the body, including the muscles of respiration, which is accordingly temporarily suspended. The spasms are intensely painful and exhausting. They are at first brought on by external stimuli such as noise, light or jolting the bed, but later they occur spontaneously. The bouts of spasm rise to a crescendo of frequency and intensity and the patient may die in one of these from respiratory failure. If he can survive for five days the attacks usually begin to abate and he is likely to recover, the attacks seldom persisting for longer than fourteen days. The following types of tetanus are described:

Type I.—Symptoms confined regionally with, for instance, tonicity

empyema. The progress of this gangrene is relentless unless active measures are taken to arrest it. Meleney, who worked out the bacteriology of the condition, advised the application of zinc peroxide; but other workers have not had the same success with this material which needs to be specially prepared, otherwise its action is uncertain. In nearly every case a diathermy excision of the wound edge will arrest the progress of the ulceration, and a successful issue has been reported following parenteral penicillin therapy (*Lancet*, 1945, **1**, 434).

Bacillus Pyocyanæus

Wounds may become infected with *B. pyocyanœus*. This organism leads to the production of a light blue or green pus and the wound exudes a characteristic smell. The appearance of symptoms indicating an infection with *B. pyocyanœus* generally means that other and more dangerous organisms are absent and the prognosis is therefore correspondingly good. On the other hand the *B. pyocyanœus* itself may be very hard to overcome and it is responsible for disheartening delay in the healing of chronically infected wounds and the postponement of such measures as skin-grafting when these may be required urgently to prevent scarring and deformity. An application of a dressing of 2 per cent. acetic acid or household vinegar usually serves to overcome the infection and allows the wound to heal. Where there are excessive granulations these may be cauterised by the application of a silver nitrate stick. " Gram-negative powder " (p. 36) may be used instead of acetic acid; penicillin is without effect.

Tetanus

Infection with the *Clostridium tetani* is relatively common after non-surgical wounds, particularly where there has been much tissue destruction and contamination For this reason all patients with such injuries are treated as a routine with an intramuscular injection of 3,000 International Units of anti-tetanic serum as soon as possible. This dose should be repeated on the third day and then at weekly intervals for four weeks if, from the nature of the wound, tetanus is likely. Soldiers, before going on active service, now have prophylactic injections of toxoid, and this is said to confer an immunity at least for many years if not permanently. Large-scale investigations of this measure indicate that it is effective, but we are not yet in a position to be able to dispense with the necessity of giving anti-toxin as well when the soldier becomes wounded.

Tetanus, although common only after infected wounds, may rarely complicate surgical wounds. The source of infection in these cases

two-hourly or phenobarbitone gr. i four-hourly may be all that is required.

General treatment consists in the prevention of hypostatic and aspiration broncho-pneumonia by giving a full course of sulphonamide. The patient is using up a tremendous amount of energy during the spasms and the profuse sweating demands replacement of fluid and chlorides. At least 4 pints of fluid in the form of lemonade, Bovril, and egg and milk are given in the twenty-four hours. The patient may be able to take these himself without exciting a spasm, but in more severe cases it will be necessary to pass a stomach tube and this should be done when the patient is most deeply under Avertin.

In very severe cases continuous light narcosis can be maintained by an intravenous drip of 0·5 per cent. Pentothal in glucose-saline, the needle being retained in the vein during spasms by incorporating the projecting shaft in an encircling plaster-of-Paris bandage. After twelve hours the strength of Pentothal solution may be reduced to 0·25 per cent. or less, so that the lightest possible plane of narcosis is maintained without having to slow the drip down so much that it stops altogether. The patient is nursed in the prone position with pillows under the pelvis so that, with the head turned to one side, saliva dribbles away from the mouth by gravity without the necessity for swabbing which might excite a spasm. A Ryle's tube is passed into the stomach and the patient is fed through this. A catheter is tied into the bladder, and the ears are plugged with wool. The risks of bed-sores must be taken because the patient should on no account be moved for fear of precipitating a spasm, and pressure points are therefore carefully protected. Fæces, which leak from the anus, are collected in a mackintosh sheet strapped to the backs of the thighs, and oxygen is blown into an oral airway at the rate of about half a litre a minute. A full course of sulphonamide is prescribed as a prophylaxis against pneumonia and the patient is screened from draughts.

Hæmorrhage

Reactionary

In grossly infected wounds there is always the problem of hæmorrhage. Reactionary hæmorrhage may take place in either a clean or a dirty wound and is due to the slipping of a ligature or to bleeding from an unligatured but partly thrombosed vessel as the blood-pressure recovers subsequent to the operation. It occurs within forty-eight hours and is treated first of all expectantly if the blood-loss is not severe. A quarter of a grain of morphia is given and pressure is applied

or twitching of one limb (*not necessarily the wounded limb*). Good prognosis.

Type II.—Generalised prodromal tonicity never going on to spasms. Good prognosis.

Type III.—Generalised prodromal tonicity passing on to spasms. This is the commonest type, and the prognosis depends upon the interval between the appearance of the prodromal symptoms and the onset of the spasms.

Type IV.—Splanchnic tetanus, where the muscles of deglutition and respiration are mainly affected. Usually follows an intra-abdominal infection. Prognosis bad.

Type V.—Cephalic tetanus following wounds of the head and neck with affection of the cranial nerves, particularly the seventh. Prognosis good.

Treatment is considered under four headings :

Antitoxin

As soon as the condition is diagnosed 200,000 International Units are injected intravenously. In patients with anaphylactic history desensitisation must be carried out first and, should evidences of anaphylaxis appear, adrenalin ♏ vij is injected subcutaneously. The intravenous route is the most practicable in tetanic patients and the experimental evidence is now on the whole in favour of it. If symptoms are still present 50,000 International Units are injected each seventh day following the first injection.

The Wound is disturbed as little as possible and is not touched until an hour after the injection of antitoxin. It should then be laid well open and, without damaging the defensive barriers, necrotic material and foreign bodies should be gently removed. Carrel-Dakin's tubes should be placed in the wound, and this should be irrigated with hydrogen peroxide 10 volumes, half-strength, four-hourly.

The Spasms, if of moderate degree, are best controlled by Avertin given per rectum in doses of 0·1 gram per kilogram of body-weight. The effect is likely to last for about five hours, after which the Avertin may be repeated as required until the attacks have abated. As prolonged treatment of this type is liable to lead to cyanosis from poor ventilation of the lungs, warm oxygen should be given through a Boothby, Lovelace, Bulbulian (B.L.B.) mask or run in through nasal catheters. Paraldehyde ʒ i in saline ℥ ij per stone of body-weight and given by the rectum is an efficient substitute for Avertin, and chloroform may tide the patient over whilst a basal narcotic is being prepared. For very mild type II cases potassium bromide gr. xx

the bleeding point cannot be found, then the wound may be packed firmly with gauze and the skin sutured tightly over this. If practicable an elastic bandage may be used as well. In forty-eight hours the packing may be removed in the theatre. Either the bleeding will have stopped or the bleeding point will be obvious and can be ligatured. Rarely it will be necessary to repeat the packing and suture of the skin for a further forty-eight hours.

Proximal ligature of the main artery to the part is not indicated because the new incision almost invariably becomes infected and there is a risk of a further and more dangerous secondary hæmorrhage higher up. Moreover, the blood-supply to the part may be precarious and ligature of the main vessel will lead to gangrene. Most authorities advise *simultaneous ligature of the accompanying vein* when an artery, such as the brachial or femoral, demands ligature, on the grounds that the passive congestion so caused will encourage the expansion of collaterals, that the slower circulation allows free interchange between the blood and the tissues, and that the accumulation of katabolites in the capillaries causes them to dilate fully. Whether these theoretical advantages operate in practice is, however, still open to question.

Finally the patient may require transfusion to restore the volume of circulating fluid, and the grouping of such a patient should have been one of the measures adopted as soon as the warning hæmorrhage appeared and is advisable in all cases where such a catastrophe can be anticipated.

Chronic Sepsis

The advent of penicillin, together with the practice of covering as many wounds as possible with skin, has been followed by a striking diminution in the incidence of chronic sepsis. In 1943 the problem of chronic sepsis in war-wounds was so serious that a committee was formed especially to examine this question ; in 1944 the incidence had so dwindled that it ceased to constitute a major administrative or therapeutic problem. Nevertheless, a proportion of septic cases inevitably become chronic, and we must examine the methods applied in the management of these.

Chronic sepsis in a wound must be regarded as both a local and a general problem. The wound itself is carefully investigated in order to eliminate the causes of chronicity susceptible to treatment. Thus, pockets of pus are given free drainage ; the force of gravity is enlisted to empty collections that are attempting to drain " up hill ", either by placing fresh drainage tubes in the bottom of the sump or by altering

to the part. A limb should be elevated and posture may help to control bleeding from a thyroid or tonsillar bed. If the bleeding persists it is necessary to take the patient back to the theatre and reopen the wound *under an anæsthetic. The bleeding point is then sought and ligatured.* The most anxious cases of reactionary hæmorrhage are those which take place within a cavity such as the abdomen or chest. A close watch is kept on the pulse-rate, blood-pressure and colour of the patient, and if these indicate that bleeding is still taking place despite the exhibition of full doses of morphia then there is nothing for it but to reopen the abdominal or chest cavity and ligature the bleeding vessel.

SECONDARY

Secondary hæmorrhage occurs only in septic wounds and it is due to proteolytic ferments acting on the vessel-wall and eroding it. It should be anticipated between the tenth and sixteenth days in all septic wounds in close contact with large vessels and in septic amputations. On the notes of such cases the warning should be written " beware of secondary hæmorrhage after seven days " and the nursing staff should be instructed as to what to expect. The patient should be " grouped " in case a transfusion is necessary later. Generally the massive hæmorrhage is preceded by the discharge from the wound of a little red blood or dark clots. This " red warning " should never be disregarded and every preparation must be made for what may be a torrential hæmorrhage in the next few hours.

The part, if a limb, should be immobilised in a splint and full doses of morphia prescribed. A tourniquet and an elastic bandage are placed ready beside the bed, together with a dressing trolley. The massive hæmorrhage may be ushered in by a desire to go to stool; this is followed by furious bleeding and a degree of collapse out of all proportion to the amount of blood lost. If the bleeding is from a limb, a tourniquet should be applied at once. The site of the bleeding or the amputation stump may then be bound firmly with the elastic bandage, the tourniquet is removed and this may suffice to stop the bleeding. But if it is unsuccessful, or if the bleeding is from a site such as the buttock or the neck where such a method is impracticable, then (the tourniquet having been temporarily re-applied in the case of a limb), the patient should be taken at once to the theatre and under a general anæsthetic the wound is explored. If the bleeding point is found it should be ligatured with silk. If the hæmorrhage is occurring from a length of artery which is partially clotted, then ligatures should be applied to the vessel both above and below the clot, and the length of artery containing the clot and the perforation should be excised. If

the bleeding point cannot be found, then the wound may be packed firmly with gauze and the skin sutured tightly over this. If practicable an elastic bandage may be used as well. In forty-eight hours the packing may be removed in the theatre. Either the bleeding will have stopped or the bleeding point will be obvious and can be ligatured. Rarely it will be necessary to repeat the packing and suture of the skin for a further forty-eight hours.

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the posture of the patient ; sequestra and other foreign bodies are removed ; and a culture is taken from the wound to exclude organisms, such as *Koch's bacillus*, specific to chronic infections. Although penicillin is probably the most valuable single agent in the prophylaxis of chronic sepsis, its use (either locally or parenterally) in an established case is most disappointing. This is because the organisms are locked in fibrous tissue and an effective concentration of the drug at the site of infection is almost impossible to attain. The general condition of these patients requires careful attention. They have a typical subicteric, waxy appearance, though rarely in these days suffering from " waxy disease " ; they often have œdema of the ankles and they are anæmic. This clinical picture is due to hypoproteinæmia. Proteins are utilised in the manufacture of leucocytes ; protein is lost in the discharges from the wound at about the rate of 5 g. per 100 c.cm. of pus ; and the break-down of body proteins is abnormally active owing to the increased metabolism which a long-standing fever occasions. Serum-protein estimations are not necessary to gauge the degree of hypoproteinæmia which runs *pari passu* with the hæmoglobin concentration. The hæmoglobin level is therefore frequently assessed and whole-blood transfusions given to maintain a concentration as near to normal as possible. The patient is fed, not on an invalid diet, but on a diet rich in proteins containing as much lean meat as can be digested, and supplemented by Marmite and other palatable sources of protein. In facio-maxillary injuries, which require feeding through a stomach-tube, and in other cases where only fluids can be taken, the following diet (recommended by the Army authorities) may be used :

Milk	20 oz.	equals	Protein	138 g.
Milk powder	14 oz.		Fat	62 g.
Ovaltine	½ oz.		Carbohydrate	358 g.
Eggs	2		Calories	2,580
Sugar	5 oz.		Calcium	4,380 mg.
Meat extract	¼ oz.		Iron	44 mg.
Benger's Food	2 oz.		Vitamin A	6,100 Int. Units
Fruit juice	2 oz.		Vitamin B_1	850 Int. Units
Cod-liver oil	½ oz.		Riboflavin	7 mg.
Olive-oil	½ oz.		Nicotinic acid	18 mg.
*Compound vitamin	tablet 1		Vitamin C	60 mg.
*Ferrous sulphate (gr. iij)	tablet 1		Vitamin D	700 Int. Units

**crushed and added to feeds*

The manufacture of protein hydrolysates which can be given by the mouth or introduced down a stomach-tube may, in the near future, solve the problem of the high protein diet.

In addition to the measures outlined above the patient with a chronically septic wound should be nursed, as far as possible, in the fresh air and should be subjected to controlled doses of natural or artificial sunlight.

III. SCARS

All scars should be massaged lightly with lanoline or other emollient as soon as they have healed. This renders the scar supple and prevents it adhering to the underlying tissue and becoming dimpled.

Keloid

After operations for the excision of tuberculous glands and sometimes after other operations or burns, particularly on exposed parts of the body such as the face and neck, there is a tendency for the scar to become thickened, raised, puckered and red. This keloidal formation is especially liable to occur in an incision which has had to cross the natural creases of the skin, and in vertical rather than in transverse incisions. Its incidence in the covered parts of the body is not high and in any case it is not, in these situations, a troublesome complication. In the face and neck, however, it may lead to distressing disfigurement and must be avoided if possible.

Prophylaxis

Some plastic surgeons advise a course of superficial X-rays to the part before the original operation, but this is probably not so important as post-operative radiation. Where an X-ray plant is available and under expert supervision, *superficial X-rays* should be given as a routine to the *scars of operations on the face and neck*, particularly after operations for the excision of tuberculous glands. In most cases the treatment can be started on the *tenth post-operative day* when the wound has healed and the stitches or clips have been removed. In the case of a tuberculous abscess in which there is a discharging sinus, it is better to wait three weeks. The radiation will delay the healing of the sinus, but it is better to submit to this inconvenience than to risk the appearance of a keloid scar.

Treatment

If a keloid scar appears it can be treated by radiation, with or without excision. Where the laxity and abundance of the surrounding

tissue allow it, *excision combined with radiation* is the best method of treatment. The scar is subjected to a pre-operative course of superficial X-rays, it is then excised and the wound sutured ; ten days later a further course of superficial X-rays is given to the new scar. With this treatment a very considerable improvement in the appearance of the scar is obtained. *Simple excision of the scar* without radiation is not indicated, because the second scar may develop a worse keloid than the first.

If the keloid is of such breadth and substance that its excision would leave a raw surface that could only be covered by bringing the edges together under tension, then two methods of treatment are available. The *keloid may be excised*, and the resulting raw area *skin-grafted* ; after which the graft is treated lightly with superficial X-rays. This operation, however, may be deemed to produce as unsightly an effect as the one which it is designed to remove and as an alternative *radiation without excision* may be practised. Again superficial X-rays are to be preferred, but in cases where the patient cannot be brought to the X-ray plant and where *radium needles* can be obtained, there is a further method. A sufficient number of short *radium needles* (screened by $\frac{1}{2}$–$\frac{3}{4}$ mm. of platinum and of linear intensity 5 mg. per cm.) are obtained so that their total length equals the length of the scar to be treated. The needles are then placed transversely across the sticky side of pieces of adhesive strapping 2 in. in length and slightly narrower than the length of the needles so that the ends of these project slightly beyond the sides of the strapping. The needles are then applied directly to the scar and strapped on the skin so that their ends are touching (Fig. 4). They are left on for $2\frac{1}{4}$ hours and only one application is necessary. The shorter the needles the more accurately they can conform to the irregularities of a tortuous scar. In this way each centimetre of scar receives 5 mg. for $2\frac{1}{4}$ hours. The method though ready of application is not so satisfactory as superficial X-rays, as there is not the same uniformity of radiation. Further it is liable to cause a linear " sun-burnt " mark which may persist for many months.

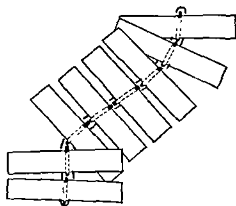


FIG 4 —Radium needles strapped to a keloid scar

Painful Scars

Painful scars may be exceptionally troublesome. They are generally due to the involvement of a cutaneous or subcutaneous nerve in dense fibrous tissue, and may often be avoided by paying particular attention to the integrity of such nerves at operation. The ilio-inguinal nerve often suffers in this respect in operations for the cure of hernia. Painful scars can be irradiated and the softening of the fibrous tissue engendered may relieve the pain. In any event if the pain is sufficiently "real" and sufficiently severe to demand active treatment, then this should be undertaken before it becomes an obsession. Operative treatment to *excise the scar*, to *release the offending nerve* from scar tissue or to *cut the nerve higher up* and embed it elsewhere is indicated only *if the pain can be abolished by local anæsthesia.* Some experts have claimed successes by *alcohol injections* into the nerve itself, but I have not been impressed with the results which I have seen of this treatment. *Sympathectomy* is practised by some surgeons for this complication.

Scars over Joints

Where scars run across joints, care must be taken to see that contraction of the scar does not produce deformity. If taken in time this complication can be prevented by splintage; the splints are removed three or four times a day for active exercises and are finally discarded when the scar has matured and there is no further tendency for it to contract. If deformity is already established, then the scar must be excised and the joint placed in the optimum position to prevent a recurrence before irreversible changes have taken place in the joint itself to render this impossible. The raw area is skin-grafted and, as soon as the graft has taken, the splints are removed four times a day for active exercises.

Ulceration and Epithelioma

Ulceration in an old scar is a troublesome complication to treat conservatively. Neoplastic change is likely and it is best to excise the scar and to skin-graft the resulting raw area. Should neoplastic change have already occurred, the prognosis is still good, as these growths are only slightly malignant. Block dissection of the regional lymph nodes would be indicated only if they were clinically involved.

IV. BURNS

Degrees

Burns and scalds were originally divided by Dupuytren into six degrees depending upon their depth and extent. Nowadays the last

four of these degrees are all grouped together as third-degree burns, because no purpose, as far as treatment or prognosis is concerned, is served by separating them.

First-degree burns cause erythema of the skin. Second-degree burns cause blistering ; and third-degree burns, involving the whole thickness of the skin and sometimes penetrating more deeply, appear as white escharotic patches or there is charring.

Shock

The first consideration in dealing with a severely burnt patient is that of shock. The clinical features of this syndrome have been described above, and it may be noted that many burnt patients present an uncomplicated picture of shock in that there is not the confusing element of blood-loss. Treatment for shock—a warm bed, with an electric cradle if necessary, the foot of the bed raised, morphia in full doses and fluids (if possible in the form of sweetened tea)—is instituted at once (see table).

TABLE OF SEDATIVES

Age	*Dose*	
Children		
1 month	Tinct. Camph.Co.	♏ iij
2 months	,, ,, ,,	♏ vi
3 ,,	,, ,, ,,	♏ x
6 ,,	Tinct. Opii	♏ i
1 year	,, ,,	♏ iij
Over 1 year	,, ,,	♏ ij for each year
Adults		
12–20 years	Tinct. Opii	♏ xx–xxx
Over 20 :		
Men	I.M.H.	gr. $\frac{1}{3}$–$\frac{1}{2}$
Women	,,	gr. $\frac{1}{4}$–$\frac{1}{3}$

If the patient is very shocked or if burns about the lips and face preclude drinking, then plasma is run into a vein according to the principles enunciated above (p 8). Usually between 1 and 3 pints of plasma will be required in a moderately severe case. Attempts have been made to calculate the volume of plasma required from the hæmoglobin concentration, but these have not been found to be so satisfactory in practice as criteria based on a consideration of the patient's general condition, temperature of the extremities, pulse-rate and blood-pressure. Blood is in these cases a less effective substitute and gum-saline ranks below blood. The injection of saline or glucose

intravenously is contra-indicated at this stage because the fluid rapidly leaks out through the dilated capillaries and no permanent addition is made to the volume of the circulating fluid. In fact, the sodium or chlorine ions may themselves escape and, by setting up an osmotic tension outside the vessels, withdraw still more fluid away from the circulation, so that the patient's state is worse than before. The plasma is run in at the rate of about a pint in the first ten minutes, and thereafter, if required, at the rate of a pint in two hours. As soon as the blood-pressure and pulse-rate indicate that the patient is recovering, the intravenous drip-apparatus is taken down.

Oxygen may be required and, if the face is unburnt, is best given through a B.L.B. mask. As soon as the patient has recovered from shock, he is taken to the theatre and there, in second- and third-degree burns, the burnt area is dealt with according to the predilection of the surgeon in charge.

Local Treatment

First-aid

Having taken all possible steps to overcome shock, some form of dressing will have to be applied to the burnt surface itself. First-aid treatment need not take into account the degree of burn. For the majority of burns of whatever degree the best treatment is to sprinkle penicillin or sulphonamide powder on to the part and apply a compress of sodium bicarbonate solution or normal saline. This application is soothing, protects in a certain measure against infection and is generally available. If the burn is of great extent and considerations of saving life outweigh all others, then some form of coagulating agent, such as tannic jelly or a 10 per cent. solution of tannic acid itself, may be applied after dusting with penicillin or sulphonamide powder. This application, by relieving pain and by preventing exudation of fluid from the burnt surface, is the best for combating shock. Patients *in extremis* from severe burns should be lifted gently, clothes and all, into a bath containing a weak solution of tannic acid heated to body temperature. The clothes may subsequently be cut off in the bath when recovery is sufficiently advanced.

Definitive

As the ensuing account is confined primarily to considerations of after-treatment, no attempt will be made to evaluate between the different methods of dealing with the local condition. Opinions vary widely and no agreement is yet in sight. In fact it is difficult to understand why people get so hot about burns. During the last few

years I have been privileged to see large numbers of cases treated by different methods and, *provided certain principles are observed,* there is little to choose between them.

My present practice is as follows:

With *first-degree burns* no treatment other than a sodium bicarbonate compress is necessary, except that gentle inunction with lanoline after twenty-four hours may prevent the stiff leathery feeling from developing in first-degree burns of the face.

Second-degree burns of the hands and face (together with second-degree burns elsewhere when treated under conditions of active service), after appropriate surgical toilet, are "frosted" with penicillin powder and covered by *tulle gras.* If there is no infection this dressing is left undisturbed for ten days. In the case of burnt hands, the fingers are each bandaged separately and it is essential that movement of all joints should be encouraged from the first.

Second-degree burns elsewhere are satisfactorily treated by thorough cleansing with saline under anæsthetic and by tanning lightly with a single application successively of 1 per cent. gentian violet, 10 per cent. tannic acid, and 10 per cent. silver nitrate, without waiting for the previous application to dry. The edges of the tan should be painted with 1 per cent. gentian violet each day to prevent infection gaining access as the crust contracts. Cracks in the crust should be similarly treated. If the whole circumference of the limb has been tanned, then the crust should be split longitudinally throughout its length on two sides, so that the part distal to the circumferential tan is not constricted and strangulated when reactionary œdema causes the tissues to swell. In forty-eight hours, by which time this reaction has reached its maximum, the ribbon-like raw areas on either side, which have been caused by the separation of the two halves of the crust, can be re-tanned. Normally the tan will begin to separate in fourteen days and will gradually come away, leaving a healed surface underneath.

Third-degree burns are best treated by means of a saline solution. When an extensive second-degree burn contains a few islands of third-degree burn, then this may be tanned. The greater part of the area will heal normally under the crust, but the islands of third-degree burn may break down and can be treated with saline compresses when the rest of the crust has separated

Burns which are primarily third-degree and second-degree burns which have become "third-degree" because of sepsis (*vide infra*) and from which the crust has been removed are treated as follows:

If the area is a relatively small patch upon a limb or on the trunk,

then *saline compresses* are applied and kept perpetually moist by dripping normal or hypertonic saline on to the compress at intervals. The compress itself should be changed every four hours for the first few days, but as the sloughs begin to separate and the granulations become clean, the change need not be effected so frequently. In order to prevent pain it is convenient to put a layer of *tulle gras* soaked in Vaseline and impregnated with penicillin or sulphonamide powder immediately up against the raw surface. The *tulle gras* need only be changed every two or three days. The interposition of this layer of *tulle gras* between the raw surface and the saline compress makes the changing of the latter an almost painless affair. As soon as the granulations are free from sloughs they may be *skin-grafted*, and this operation should be undertaken at the earliest possible opportunity to prevent scarring and contractures.

If the burnt area on a limb is extensive, then the whole limb may be encased in a water-tight bag (Bunyan bag) which is secured firmly but not too tightly at the proximal end of the limb and the burn is irrigated with saline or hypochlorite solution. Between irrigations the bag is lightly distended with air or oxygen.

If the third-degree burns involve the trunk extensively, then the patient should lie in a bath of normal saline at body-temperature for as long a period as possible. In centres devoted to the treatment of burns, baths are constructed through which flows a constant stream of warm saline, but an almost equally effective substitute is to fill a bath with 32 gallons of warm water to which a gallon of brine is added. This is then kept warm by the addition of jugs of hot normal saline. The patient can stay in the bath for hours at a time and he derives immeasurable comfort from this. Patients look forward with pathetic eagerness for their turn in the bath when their otherwise continual pain and discomfort will be eased.

On coming out of the bath the granulations are treated with saline compresses and in this way the " drawing " pains associated with drying granulations are prevented. If the patient has to lie on any part of the raw surface, then this is covered with *tulle gras* impregnated with Vaseline and a saline compress. The areas are skin-grafted as soon as the granulations have been prepared.

Special sites

Burns of the *eyes* are liable to be followed by adhesions of the lids to the conjunctivæ (symblepharon) and of adhesions of the lids to each other (ankyloblepharon). The eyes are washed out with sodium bicarbonate solution many times a day, and once a day a glass rod

covered with Vaseline is passed under each lid to the limit of the conjunctival reflection. If the mucous membrane of the *nose* is affected, this should be syringed with 1·5 per cent. saline to which adrenalin solution, 1 : 1,000, has been added in the proportion of 2 minims to each ounce of saline. Burns of the *neck* should be splinted so that the burnt area is well stretched, and this will prevent contracture deformities developing subsequently. The head and neck are conveniently immobilised by means of a back-splint between the shoulders and a foot-piece across the top of the head. If a *limb* is burnt it should be splinted in flexion or extension, depending upon the site of the burn, in order to prevent contracture subsequently. If stiffness develops in burns of the hand, the fingers should be splinted in " the position of function " as recommended by Bodenham (*Lancet*, 1943, 1, 298). The wrist should be in dorsiflexion, the fingers partially flexed and the thumb in apposition with the index. This position is best maintained by means of an aluminium splint, which can be washed, but plaster-of-Paris makes a satisfactory substitute. The splint is removed several times a day to allow active movements in the fingers. Burns of the *perineum* are troublesome conditions to nurse. Children are best treated in Bryant's suspension ; adults should have the legs splinted in abduction and a daily enema will usually avoid soiling the coagulum. When a patient is *badly burnt on both surfaces* of the body it will be impossible to prevent him from lying on some part of the burnt area. If this cannot be avoided, clean towels should be laid over the sheets and the mackintosh drawsheet dispensed with, otherwise perspiration will tend to render the coagulum sodden.

Complications

Toxæmia

In from twelve to forty-eight hours the patient may develop acute toxæmia The symptoms of this condition are similar to those of shock, in that there is collapse, a rapid thready pulse and a low blood-pressure , but it may be distinguished from shock because of its delayed onset and (from the rare form of delayed shock) by an elevation of temperature, the appearance of albumen in the urine and icterus The appearance of a few red blood-cells in the urine is almost universal in shock and does not indicate toxæmia. This syndrome is thought to be due to liver poisoning from the products of disintegration at the site of the burn and it is treated by the free administration of fluid and glucose, if necessary intravenously. Whereas it will be noted that in the stage of shock intravenous glucose was contra-indicated, the late onset of toxæmia presupposes that by this time shock will have abated and,

capillary tone having recovered, the contra-indication therefore no longer exists.

Sepsis

If second-degree burns which have been coagulated become septic then they constitute exactly the same problem as third-degree burns. In fact, because the dermis has now been affected by the septic process, they are tantamount to third-degree burns. Third-degree burns, as we have seen, are treated by some form of saline dressing, so that these septic second-degree burns should be similarly treated.

When a second-degree burn becomes septic there will usually be an elevation of the temperature and an increased pulse-rate. The crust, if the burn has been tanned, will be raised by the collection first of sero-purulent and later of frankly purulent material underneath it and this will start to ooze from the edge of the coagulum and through cracks in its substance. The ideal is to remove the coagulum with scissors and to treat the underlying surface with saline compresses, as described for third-degree burns. It must be borne in mind that the removal of such a crust does nothing to lessen the toxæmia of these patients. In other words, it is not like opening an abscess, and often, where the septic burns are very extensive, the patient is less comfortable when the crust has been removed than he was before. If there are no adequate facilities for completely immersing a patient suffering from very extensive burns in a saline bath for long periods of the day, it may occasionally be wise to leave the crusts *in situ* until the patient can be moved to such a centre, or until his general condition will permit of large raw surfaces being exposed.

After a while these patients become profoundly anæmic, so that frequent hæmoglobin estimations should be made, and the hæmoglobin level adjusted by whole-blood transfusions and iron A diet rich in protein is prescribed as recommended in the section on Chronic Sepsis (p. 49).

Other Complications

Other complications which must be watched for and treated along general lines are *broncho-pneumonia* and rarely *duodenal* or *jejunal ulcer*. Broncho-pneumonia is common only after burns of the front of the face and chest and is probably due to the inhalation of flame and hot gases at the time of the accident. *Pulmonary œdema* should not appear if care is taken not to give an overdose of sodium chloride intravenously.

CHAPTER III

THE EAR, NOSE AND THROAT

I. THE MASTOID

Acute

AFTER operations on an acutely infected mastoid a drain is left in the mastoid wound. This is either made of rubber-glove material or Layton's pipe-drain is inserted. The pipe-drain consists of a short length of rubber tubing split down one side with holes cut in the other. It is as efficient as rubber-glove drainage and more manageable. As the mastoid infection is practically invariably with the hæmolytic streptococcus or rarely with the pneumococcus, a course of penicillin is given (p. 26). The external auditory meatus is mopped out four-hourly with cotton-wool on the end of a match-stick, and Layton advises that a "mopping chart" should be kept. This is a record of the number of moppings required on each occasion to achieve a dry meatus and is a valuable index of the progress of the case. On the evening of the day on which the operation was performed the bandage may be loosened and adjusted, and the outside dressings are changed. After forty-eight hours the first dressing is performed. An adult patient is given morphia gr. ¼, and children a corresponding dose of analgesic (p. 5). A mask should be worn to prevent infection of the mastoid wound with other organisms, and this practice should be adhered to for at least the first few days. The prevention of a mixed infection in these cases is of vital importance, as contamination of the wound with secondary organisms is the commonest cause of chronicity. At this dressing the drain is removed and a fresh sterile drain inserted. In order to prevent skin organisms from gaining access to the wound, the surrounding skin is carefully and thoroughly cleansed with spirit, making sure that no debris is carried into the wound, and Vaseline is applied to the edge of the incision. Layton, to whom all Guy's men are so much indebted for instruction on these matters, then applies a gauze sponge, cut in a semi-circular manner, over the wound. The semi-circular edge is placed well into the retro-auricular groove, so that when the pinna is bandaged back there is no contact between skin and skin. Dressings are arranged so that the drain is not pressed unkindly into the mastoid cavity and a mastoid bandage (Fig. 5) keeps the whole secure.



(a)



(b)



(c)



(d)

FIG 5 —The mastoid bandage.

(a) The bandage is put on and the end is split.
(b) The handle of the scissors is used for drawing one of the split ends through.
(c) The bandage tied.
(d) The meatus can be cleaned without removal of the bandage.

This bandage must be applied so that the external auditory meatus is accessible for mopping.

The dressing is repeated daily and the drain is kept in the mastoid wound until there is no further discharge from the external auditory meatus and the mopping chart records " nil ". It is important to see that the hair is kept well away from the wound and the former may have to be clipped during the course of treatment. In girls the remaining long hair should be smeared plentifully with Vaseline and a steel comb is used to plaster it down towards the opposite side.

Fluids are prescribed freely and the bowels attended to. As the tip of the mastoid process is often removed, there is sometimes painful restriction of the movements of the neck from interference with the action of the sterno-mastoid muscles and a feeding-cup with a spout will be necessary at first.

Complications

The complications of acute mastoidectomy are serious and their early detection is of the greatest importance. Immediately the child recovers from the anæsthetic he should be made to show his teeth and close his eyes in order to detect a possible *paralysis of the facial nerve.* This may be evident at once, in which case it is due to damage sustained by the nerve at the time of the operation (an exceptionally rare accident in operations for acute mastoiditis) or it may come on later when it is due to œdema compressing the nerve. The presence of facial palsy must be reported at once to the surgeon, who will have to consider a decompression operation. A persistently raised temperature, vomiting or vertigo suggests the possibility of *meningitis, labyrinthitis* or *cerebral abscess.* In meningitis the child will be acutely ill. In addition to pyrexia and vomiting there will be neck rigidity or head retraction and a positive Kernig's sign. True neck rigidity may be felt first in the deep neck muscles by careful palpation and can be distinguished from the stiff neck of torn sterno-mastoid muscles by the fact that resistance is only to flexion of the neck, rotation and extension being relatively free. Headache is likely to be very severe. In labyrinthitis the predominant symptoms are vertigo and vomiting. There will in addition be a nystagmus with a rotary element. Cerebral abscess is usually the most chronic of the three and an unexplained temperature may persist for weeks before central nervous symptoms lead to a correct diagnosis. The treatment of all these conditions is beyond the scope of this book and each requires expert supervision. *Lateral sinus thrombosis* may cause a persistent pyrexia or rigors due to liberation of septic material into the blood-stream. It may lead to *jugular-vein*

thrombosis, when there will be tenderness over the course of the jugular vein and swelling and œdema of that side of the neck. If more than one rigor occurs the jugular vein may require ligation in the neck to prevent the liberation of septic thrombi into the blood-stream.

A rare complication of mastoiditis is the so-called *otitic hydrocephalus*. This is probably due to a spreading thrombosis reaching the superior sagittal sinus, and is evidenced by vomiting, headache and papillœdema without as a rule any rise of temperature. Treatment is directed towards reducing the intracranial pressure (p. 261) and magnesium sulphate by the rectum is usually the most satisfactory form of treatment. After acute infections of the mastoid the urine should be tested to detect the onset of an *acute focal nephritis*.

If *the lateral sinus was accidentally wounded* during the course of the operation the mastoid cavity will have been plugged. This plug can be removed in forty-eight to seventy-two hours under Pentothal anæsthesia in the theatre, in case repacking is necessary.

A *persistent discharge* from the meatus or from the mastoid wound may be due to dermatitis, deficient Eustachian drainage, sequestration of the temporal bone or sepsis within the mouth.

The measures outlined above should suffice to prevent infection of the surrounding skin. If dermatitis appears it is best treated with Unguentum Hydrarg.Oxid.Flav. Deficient Eustachian drainage is combated by getting the patient to assume an upright posture in bed, by breathing exercises and by the instillation of paraffin or Argyrol drops into the nose. Septic teeth and tonsils may require attention and the mastoid wound should be investigated for a sequestrum.

Chronic

After operations for chronic mastoiditis the post-auricular wound is stitched up and drainage is obtained through an enlarged opening in the external auditory meatus into which is inserted an iodoform gauze pack In place of the iodoform, penicillin powder may be used to impregnate the pack. The dressing is left undisturbed until the fifth day when the stitches in the mastoid wound are taken out. The pack is then removed and a fresh pack inserted. The first dressing is best performed under Pentothal anæsthesia, as it is liable to be extremely painful. The pack is changed daily until the discharge lessens, when the interval between dressings may be increased. When a dry pack is removed the patient may be pronounced cured. If the discharge is persistent, the cavity must be inspected and granulations can be cauterised with the silver nitrate stick or chromic acid fused on to a probe, and tighter packing employed.

When a *Thiersch graft* has been used to line the mastoid cavity, Logan Turner (*Diseases of the Nose, Throat and Ear*, Wright, Bristol, 1936) advises removal of the pack on the fifth day and its reinsertion for a further two days; thereafter the "wet" method is adopted. Ten drops of hydrogen peroxide (1 : 10) are instilled into the ear and allowed to remain for five minutes. The patient then sits up and the ear is syringed with warm boracic solution (boric acid ʒ j to a pint of lukewarm boiled water), the efflux being collected in a kidney-dish held to the side of the neck. The ear is then mopped dry, inflated by Politzer's method and the remaining moisture removed by mopping. Finally 10 drops of a solution made up with boric acid gr. x to rectified spirit ℥ j is instilled into the ear. This treatment is repeated at first three times a day, later once a day and then at gradually increasing intervals until the discharge ceases.

COMPLICATIONS

The complications after a chronic mastoid operation are the same as those after an acute mastoid, but *facial palsy* from injury is more likely as a more radical operation has been performed. Owing to the fact that the tip of the mastoid is not removed there is not, on the other hand, so great a tendency to a *stiff neck*. *Persistent discharge* in so far as it is due to granulations has been dealt with above. It may, however, indicate that all the diseased tissue has not been removed, and in long-standing cases a further operation may have to be considered. If the mastoid wound breaks down and a *persistent sinus* develops behind the ear, the opinion of the surgeon must be obtained in regard to the advisability of a further removal of bone or a skin plastic operation.

Owing to the use of catgut in the ligature of veins coursing across the line of the mastoid incision, a stitch abscess may develop and requires the usual treatment. *Perichondritis* of the cartilaginous meatus or of the pinna may appear secondarily to infection of the cartilaginous flap and requires hot poultices with kaolin or Antiphlogistine and, if it is available, the application of short-wave diathermy. Attention to the teeth and tonsils is as important here as with operation on the acute mastoid.

II. EPISTAXIS

It will not be appropriate to discuss here the general and local causes of epistaxis, although a consideration of these causes is necessary to prevent recurrent attacks. We are concerned primarily with the measures to be adopted to stop the bleeding.

The patient is at once put in the upright *sitting position* and made

to pinch the *lower half of his nose* firmly between the thumb and forefinger. As the bleeding often comes from a septal vessel near the front of the nares, pressure maintained in this region for a few minutes may serve to arrest the bleeding. A *sponge soaked in ice-cold water* is applied to the bridge of the nose. If a continuous trickle persists, Trotter suggested inserting a *dental gag* between the teeth and keeping the mouth widely open. The object of this is to prevent swallowing, which is very difficult with the jaw fully depressed. The negative pressure in the nasopharynx which accompanies swallowing and which may encourage post-nasal bleeding is accordingly avoided. A more evenly distributed pressure can sometimes be obtained by making a fat cigarette of cotton-wool wrung out in Decicaine 2 per cent. or hydrogen peroxide (1 : 10) and inserting this through the anterior nares before squeezing the nostrils. If serious bleeding continues despite these measures, it may be necessary to *pack the nose.*

Packing

Anterior Nares

The anterior nares are packed first. Using a good light and a nasal speculum the nostrils are packed from the front with ribbon-gauze. A long pair of forceps is necessary and the packing is done from below upwards on each side. The ends of the gauze are left hanging out of the nostrils. If this measure does not control the hæmorrhage the *anterior packing is removed* and posterior packing is performed.

Posterior Nares

Packing of the posterior nares is performed as follows. Two small sponges are wrung out in Decicaine 2 per cent. or hydrogen peroxide solution (1 : 10) and tied firmly with tape. The ends of the tape on each sponge are left twelve inches long. A rubber catheter, lubricated with paraffin, is passed into one nostril, and when the end of this appears in the nasopharynx it is seized with forceps and drawn out of the mouth. One end of the tape is tied to the catheter and the latter is then withdrawn through the nose dragging the tape through after it. A similar manœuvre is adopted with the other nostril and, by pulling on the two tapes emerging through the nostrils, the sponges are drawn firmly into the posterior nares. These tapes are then tied across the septum and cut short. The other ends of the tapes hang out of the mouth and are strapped one on each side to the cheek. As anterior packing is liable to be painful and to irritate the nasal mucosa it is wise to wait for a few minutes after inserting the sponges into the posterior

nares to see if posterior packing alone will arrest the hæmorrhage, n which case there is no need to reinsert the anterior packing.

Mollison describes a method which may render packing unnecessary, either from the back or from the front. A *rubber finger-stall* is tied with thread over a thick-walled catheter, size 4–6 French (Charrière), the catheter being inserted down to the end of the finger-stall. The outside of the finger-stall is then lubricated with paraffin and is passed by means of the catheter along the floor of the nostril. By blowing powerfully into the free end of the catheter, the finger-stall



FIG 6.—Mollison's method for controlling epistaxis.

is inflated and exerts considerable pressure on the walls of the nostril. The catheter is then clamped with a gate-clip and hitched over the ear (Fig. 6).

The Electro-cautery

If the requisite apparatus is available and before proceeding to pack the nose, a performance which is always trying to the patient, an attempt may be made to control the bleeding with the *electro-cautery*. A fenestrated nasal speculum is inserted and a plug of cotton-wool is packed through this into the nostril and retained for a few minutes. On removing the plug the bleeding point can often be observed coming from a varicosity on the septum. If the source of the trouble can be localised in this way, another plug of cotton-wool is temporarily inserted. A small pledget of cotton-wool wrung out in a solution of 5 per cent. Novocain (to which adrenalin 1 : 1,000 has been added in the proportion of 2 minims to the ounce of Novocain) is held in a pair of Spencer Wells forceps and, after removal of the plug, is pressed firmly on to the mucous membrane at the point from which the bleeding was observed to be coming. After a minute or two the pledget of wool is removed and the bleeding point touched with the electro-cautery. This, in the majority of such cases, stops the bleeding at once, or perhaps a second " touch " with the cautery may be needed.

If successful this method has many advantages over packing. It is simple, painless and quick. The effect may be permanent, and it saves the patient from the distressing and at times painful process of packing.

After-effects

The swallowing of large quantities of blood may cause *nausea and vomiting* so that, after the bleeding has been arrested, steps should be taken to combat this. A drink of iced lemon-juice and water sweetened with glucose is often refreshing and may allay these troublesome symptoms. Rarely the stomach will have to be washed out, but if this is not called for and if spontaneous vomiting has not occurred a dose of senna or cascara (p. 15) should be prescribed to clear out the bowel. *Collapse* is treated by recumbency, warmth and the administration of morphia and fluids, and is exactly comparable to post-operative shock, a complication which is discussed fully on p. 6.

Long-continued epistaxis may render a patient anæmic and iron must be given. Rarely a brisk hæmorrhage will cause such a degree of exsanguination as to demand a blood transfusion.

III. SUBMUCOUS RESECTION

After this operation the nostrils are plugged for twelve to twenty-four hours. Some surgeons use a pair of "trousers" made out of the two fingers of a rubber glove joined together at the web and packed with gauze. Other surgeons use gauze soaked in Vaseline packed directly into the nostrils. The first or "trouser" method has the advantage that the rubber does not irritate the nasal mucosa, the gauze can be removed painlessly from within the "legs" and the rubber comes away readily afterwards. If this method is used, however, the greatest care must be taken to see that the two "legs" are joined together outside the nostrils by a strong bridge of rubber, otherwise there is danger of the plug passing back into the nose and being inhaled, with disastrous consequences. If gauze is used without the protection of the fingers of a rubber glove, there is the possibility of this becoming unravelled, passing through the posterior nares and being swallowed or inhaled. To prevent this, the end which is packed in first is sometimes knotted before insertion and the nasopharynx should be inspected from time to time to see if there is any sign of the ribbon-gauze.

In both methods the packing is held in the nostrils by a piece of strapping passing under the septum and applied to the outside of the nose. Another piece of strapping across the bridge of the nose is used by some surgeons to increase the pressure, but this may cause depression of the lower part of the bridge and is usually omitted. If the strapping under the septum breaks away and the "trouser drain" comes half out, it is better removed altogether, as in this position it does

not prevent bleeding, but merely obstructs the flow of blood through the anterior nares, causing clots to collect behind and allowing a septal hæmatoma to form.

After the packing is removed in twelve to twenty-four hours, the nostrils are gently syringed with warm saline and inspected from the front with the aid of a nasal speculum. It may be necessary to remove clots with forceps, as syringing cannot be relied upon to clear these all away. Paraffin drops are instilled into the nose to prevent adhesions.

IV. THE CALDWELL LUC OPERATION OF MAXILLARY ANTROSTOMY

In the after-treatment of this operation the antrum should be left alone for four days. If, however, packing has been used, this is removed in twenty-four hours and is not renewed. Paraffin or menthol ointment is inserted into the nostril and the following prescription was advocated by St. Clair Thomson for this purpose:

℞ Mentholis	gr. i
Acidi borici	gr. v
Olei gaultheriæ	♏ i
Lanolini	℥ ij
Vaselini	℥ vi

After forty-eight hours and for the succeeding two days, the patient should inhale the vapour of a solution of Tinct. Benzoin. Co. (ʒ i to a pint of hot water) for ten minutes, three times daily. On the fourth day the nose is syringed with alkaline solution (Collun. Alkalinum B P.C.) or the solution advised by St. Clair Thomson may be used:

℞ Sod *bicarbonatis* .	*gr. v*	made into a tablet. Dissolve in 4 ounces of warm water before use.
Sod. biboratis .	gr. v	
Sod. chloridi .	gr. v	
Sacchari albi .	gr. v	

If the discharge is foul-smelling, a weak solution of potassium permanganate is to be preferred This syringing is repeated three or four times and from then, until all infection has subsided, the antrum is washed out with a pint of warm sterile saline solution, at first once daily and then at increasing intervals. As a general principle the less interference with these cases the more satisfactory the result. The

washing is performed through a Eustachian catheter attached to a Higginson's syringe. The catheter is passed through the inferior meatus and the fluid flows out through the nostril, being collected in a kidney-dish. The patient later learns to do this for himself.

An aperient is given on the day after the operation. Occasionally the antro-nasal opening and the inside of the cavity are swabbed with Argyrol 25 per cent. Frequent mouth-washes with a mildly antiseptic solution are given throughout the post-operative period. Swelling and distension of the cheek and tissues round the eye may be relieved by hot fomentations. Dentures are not worn until the wound in the mouth has healed completely.

V. TONSILLECTOMY

The patient is returned to bed lying on his left side with the left leg straight and the right leg slightly flexed and overriding the underneath leg. After operations on one side only the patient returns to bed lying on that side. A pillow may be placed in the small of the back to prevent him rolling over, but this is usually unnecessary. Such blood-stained discharges as escape from the mouth are collected in a towel under the head. As soon as the patient is well round from the anæsthetic he is sat up by rapid stages and morphia gr. $\frac{1}{4}$ is given so that oozing from the tonsillar beds is lessened.

For the first two days soups, jellies, ice-cream and custards are given and some surgeons advise steamed fish and light solids at this time. Milk is not suitable because it tends to clot and decompose, rendering the mouth unsavoury. Antiseptic mouth-washes are a great help in keeping the mouth sweet and should be frequently resorted to. There is no need to spray the throat, but antiseptic lozenges, such as Troch Glycyrrh or penicillin lozenges, are useful. Talking must be restricted during the first forty-eight hours as this increases the pain and may provoke bleeding. Pain is usually troublesome and powdered aspirin can be insufflated on to the raw surface or 2 per cent. Decicaine pastilles may be sucked. Aspirin, phenacetin and caffeine mixture is prescribed before each meal until the pain has abated.

If the cervical glands become swollen and painful a kaolin or Antiphlogistine poultice, kept in place by a crêpe bandage passing round the neck and head, helps to keep the patient immobilised and is very soothing. Ice is given to be sucked and an aperient is prescribed in twenty-four hours to get rid of swallowed blood and mucus. Clearing out the bowels in this way often has a marked effect on the patient's sense of well-being, the appetite improves and the tempera-

ture settles. In an uncomplicated case the patient gets up on the third day and can be discharged on the fifth. Sloughs usually cover the tonsillar beds for ten days and the patient should be warned not to be alarmed at the appearance of his throat.

Hæmorrhage

Hæmorrhage is the most troublesome complication of tonsillectomy. This may be reactionary or secondary. Secondary hæmorrhage comes on about seven to ten days after the operation and may be anticipated where the tonsillar beds are covered with a foul-smelling slough and where small hæmorrhages take place from underneath this slough. Secondary hæmorrhage is treated in the same way as the far commoner reactionary hæmorrhage which comes on a few hours after the operation. The routine measures adopted after tonsillectomy are designed largely to control reactionary hæmorrhage. Thus with the *upright posture, ice by the mouth and the injection of a quarter of a* grain of morphia, bleeding usually soon ceases. Should it persist, Trotter's method of inserting a gag to prevent swallowing may be tried and ice-bags are applied to the skin behind the angle of the jaw. If the bleeding continues, the tonsillar bed must be inspected. This will be occupied by a clot from under which bright red blood is welling. The clot is removed and *gauze sponges* well wrung out in hydrogen peroxide and held *on the end of Spencer Wells forceps* are pressed firmly into the cavity. If the ingredients are available, a more efficient substitute for controlling hæmorrhage than peroxide is a mixture of equal parts of Liq. Ferr. Perchlor., Liq. Hydrarg. Perchlor., and glycerine. A gauze sponge held on the end of the Spencer Wells forceps is wrung out in this solution and then dipped into powdered tannic acid and applied to the cavity; or Russell Viper Venom *('Stypven': Burroughs Wellcome) may be used instead. If the* bleeding is coming from both sides then a gauze sponge is pressed into each cavity, the handles of the Spencer Wells forceps passing over each other like crossed swords. In this way it is possible to sit opposite the patient with a Spencer Wells forceps in either hand and exert pressure on the tonsillar beds for as long as ten to twenty minutes. Special hæmostatic clamps may be used if they are available. At the end of this time the bleeding will probably have stopped. If not, the patient is taken to the theatre and, either the bleeding point sought and ligatured, or the posterior pillar of the fauces can be sewn to the anterior pillar over a plug of cotton-wool. In order to control steady oozing, *repeated small blood transfusions* are invaluable.

Other Complications

Lung abscess is a possible complication after tonsillectomy. It is usually due to the inhalation of blood or fragments of tonsil while under the anæsthetic and is rare in this country, where tonsillectomy is commonly performed with the head thrown back, so that the inverted roof of the nasopharynx acts as a sump for blood and debris. This complication often appears after some weeks and is an indication for seeking expert advice. The symptoms and signs are dealt with on p. 94.

Atrophy of the uvula occasionally occurs following tonsillectomy, but it is more often a euphemism for damage to the uvula following the guillotine operation on the second tonsil. It has some medico-legal importance.

Paralysis of the palate is a rare complication and leads to a nasal tone in the voice and even to regurgitation of fluids through the nose. A similar clinical picture is sometimes produced with a normal palate on account of the increased capacity of the nasopharynx consequent on removal of a mass of adenoid tissue. In both cases the palate should be re-educated by making the child say "K" repeatedly, accenting if possible the explosive quality of the consonant. Paralysis of the palate usually recovers spontaneously after some weeks, when the œdema of the palate has subsided and the muscles are re-educated.

VI. TRACHEOTOMY

This operation is performed for urgent respiratory obstruction, as from a foreign body in the larynx or in the case of a child during the acute stage of diphtheria. A *laryngotomy* may very occasionally be preferred, as it is easier to perform in an emergency. A laryngotomy is a temporary measure to tide the patient over such an emergency and the tube should not be left in for more than a week, otherwise erosion of the cricoid cartilage or paralysis of the cords is liable to occur. In other respects the after-treatment is the same as for tracheotomy.

After the operation the patient is returned to a warmed bed and a nurse is in attendance by the bedside day and night. In infected cases a bronchitis kettle and a steam tent are advisable or inhalation of the vapour from a solution of Tinct. Benzoin. Co. (ʒ i to a pint of hot water) may be valuable. A satisfactory tent can be made with two screens covered by a sheet. One end is left open and the nurse sits with the patient inside the tent. Under the shield of the tracheotomy tube is placed a square piece of oiled silk 6 inches by 12 inches, split to enclose the tube and smeared with zinc ointment to protect the skin. The

oiled silk is then folded to form an envelope under the tracheotomy tube and secured with safety-pins (Fig. 7). Secretions from the tube are caught in this envelope and the night-gown and bed-clothes are

Fig 7.—The oiled-silk envelope.

thereby protected from contamination. Attached to the shield (Fig. 8) are two tapes which are tied securely round the neck, and these prevent the tracheotomy tube from slipping out. The opening of the tube is covered with a dry gauze sponge, and the attendant has on the table beside her an introducer, a spare inner tube wrapped in a sterile sponge and a number of spills. These spills, which are used to keep the inner tube free from secretions, are made from 4-inch squares of linen rolled diagonally and bound with cotton. Every two hours the inner tube is removed, cleaned out and sterilised, the spare tube having meanwhile been inserted.

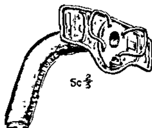


Fig 8.—Tracheotomy tube and shield

If, despite cleaning the inner tube, symptoms of urgent dyspnœa return, this is probably due to the outer tube having slipped out of the trachea. The doctor must be summoned forthwith and in the meanwhile the nurse, with the aid of an assistant, a good light, the introducer which is ready to hand and a sensible control of all her faculties, attempts the difficult and unenviable task of replacing it.

The outer tube should be changed by the doctor in five to seven days and, if it appears that the tracheotomy will be required for much longer, a rubber tube may be substituted for the metal one. Because of its softness a rubber tube should not be used unless the metal tube can be removed easily and it appears that the opening in the trachea has become established.

REMOVAL OF THE TUBE

In an infected case the discharge ceases to be purulent and becomes serous in five to fifteen days, and when this happens removal of the tracheotomy tube may be considered. After foreign-body obstruction removal may be possible in a few hours. The orifice of the tube is then occluded experimentally. If sufficient airway is proved, the tube is removed and the wound allowed to granulate. In cases of obstruction due to a foreign body, which has been removed in the meantime, it is advisable to retain the tracheotomy tube for at least three hours, otherwise its removal may be followed by emphysema of the neck. In nervous children blocking of the tracheotomy tube may cause laryngeal spasm and the experimental occlusion should be conducted during sleep. If the child still experiences difficulty in breathing during experimental occlusion, this is probably due to stenosis of the larynx, and laryngoscopic examination should be made. The first attempt to do without the tube is always made in the presence of the surgeon, who can replace the tube forthwith if the need arises.

Feeding may present a problem in tracheotomy cases, as there is often a temporary anæsthesia of the larynx which allows fluid to get into the glottis and either escape through the tracheotomy tube or be inhaled. At first, sips of sterile water should be given through a feeding-cup, but when the power of swallowing is assured, the feeding-cup may be dispensed with and the diet enriched. In difficult cases resort may be had to feeding through a nasal tube.

COMPLICATIONS

Serious complications of tracheotomy are fortunately not common. Some degree of *respiratory infection* is usual, but this generally resolves when the respirations become unhindered and the patient accommodates

himself to the tracheotomy. *Broncho-pneumonia* may be a cause of death, particularly in debilitated subjects. *Sepsis of the wound* is uncommon if stitches are not inserted beneath the tube, but if it occurs it is treated according to general principles. *Hæmorrhage* is a very fatal and fortunately rare complication, death taking place from inhalation of blood or clot.

"*Retained tube*" or the necessity for persisting with the tracheotomy is due to a variety of causes. Stenosis of the larynx may follow the diphtheritic infection or the irritation from an impacted foreign body. Its treatment is difficult and tedious, and the patient may be better off with a permanent tracheotomy. Stenosis of the larynx is encouraged by disuse. Laryngeal granulations organise and contract and, in the absence of a current of air, webs of fibrous tissue may form across the lumen. It is therefore important to remove the tracheotomy tube as soon as the proper indications obtain, otherwise it may have to be retained permanently.

"Retained tube" may follow ulceration of the tracheal mucosa due to a too high tracheotomy or to careless fitting of the tube. If this ulceration is untreated, it will produce tracheal stenosis. Should ulceration of the trachea occur, the ulcer should be cauterised with chromic acid fused on to a probe and a rubber tube may be substituted for the metal one. Alternatively a fresh tracheotomy may be performed lower down. Lastly a persistent paralysis of the vocal cords in the adducted position may be due to the diphtheritic infection and may lead to the necessity for a retained tube.

Permanent Tracheotomy

Sometimes after thyroidectomy with bilateral recurrent nerve palsy, in cases of intrinsic and extrinsic carcinoma of the larynx and

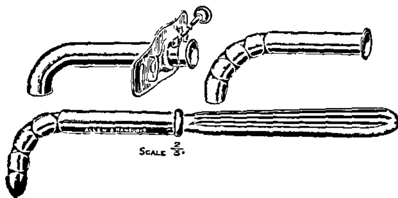


Fig. 9.—Durham's lobster-tail tube.

also with syphilitic stenosis and tuberculosis, it may be necessary to have a permanent tracheotomy. In these cases a rubber tracheotomy tube is advisable, but Durham's lobster-tail tube (Fig. 9), which hangs free in the trachea and which is supplied with an adjustable shield to fit any size of neck, may be used instead. In these circumstances the inner tube should be removed and cleaned, though not sterilised, three times a day by the patient and once a month the outer tube is removed, at first by the surgeon, sterilised and replaced ; later the patient learns to do this himself. In women a tulle scarf is worn round the neck to protect and hide the tube, and in these circumstances patients can lead relatively normal lives, though they must be careful, when they take a bath and wash their hair, not to allow water to get into the tube ; and it is not the needless precaution that it might seem to warn them against *bathing*.

CHAPTER IV

THE THYROID AND BREAST

I. THE THYROID

Post-operative Thyrotoxicosis

Convalescence from operation for simple goitre is usually uneventful. If the operation has been performed for toxic goitre, however, and particularly after operation for primary toxic goitre, there is a tendency for an acute exacerbation of the toxic symptoms to occur within forty-eight hours of the operation. This tendency is combated by a period of rest in bed and glucose therapy before the operation and, in the case of primary toxic goitre, by a pre-operative course of Lugol's iodine.

The symptoms of post-operative thyrotoxicosis may come on a few hours after the operation, or they may be delayed as long as forty-eight hours. The pulse-rate increases, the temperature may rise to 105° F. or more, the respiration-rate is raised and the patient may become restless and excitable to the verge of mania. Exophthalmos if present is usually increased. Occasionally auricular flutter may appear in a patient who has been previously fibrillating. This must be regarded as a very grave prognostic sign.

Routine Preventive Treatment

To avoid this distressing and dangerous complication, certain routine measures are adopted after every thyroidectomy for a toxic goitre. On return to his bed the patient is given a pint of 5 per cent. glucose in water by the rectum, and to this infusion is added 30 minims of Lugol's iodine and 3 grains of phenobarbitone. During the course of the ensuing twelve hours a further 30 minims of Lugol's iodine and 2 grains of phenobarbitone may be so given if required. By this time the patient may be able to take fluids by the mouth and the pre-operative dose of Lugol's iodine, namely 10 minims three times a day, is given by this route If vomiting persists, the Lugol's iodine should be given by the rectum and, unless symptoms of acute thyrotoxicosis appear, 45 minims of Lugol's iodine in the twenty-four hours should suffice. Large quantities of fluid are required and this is given by the mouth if possible. Should vomiting preclude this, a solution of 5 per cent. glucose may be given both by the rectum and intravenously. A

total of 8 pints of fluid is aimed at in each twenty-four hours for the first few days after the operation. After every fourth pint intravenously, normal saline may be substituted for the 5 per cent. glucose in distilled water. If vomiting is severe, then this substitution may be made more frequently. After ten days the dose of Lugol's iodine should be cut down to 10 minims daily and should be stopped altogether on discharging the patient. The drain is removed in forty-eight hours and the Michel clips on the fourth day.

Semi-solids may be taken from the third day and the diet is then increased, so that at the end of a week the patient is taking ordinary meals. Alcohol, coffee and meat should be withheld until the tenth day. The patient is usually fit to get up in fourteen days and may be discharged in three weeks. Return to work should be delayed until six weeks after the operation. Generally no severe toxic reaction is encountered with such a regime, apart from a rise in the pulse-rate and some pyrexia, but occasionally, despite these precautions, the evidences of post-operative thyrotoxicosis will appear.

TREATMENT OF THE ESTABLISHED CONDITION

The danger of *morphia* in this condition has been exaggerated. The restlessness and excitability may be quite uncontrollable by drugs other than those of the morphia group. The depressant effect on the respiratory and vaso-motor centres is more than compensated by the relief of strain consequent on quietening the patient. If the patient needs it, a quarter of a grain of morphia may be prescribed every four hours until the desired effect is attained or a sixteenth to a twelfth of a grain of Heroin may be substituted if morphia induces vomiting.

Hyperpyrexia is treated by *tepid sponging*, *ice-bags* and an *electric fan* by the side of the bed. This rise of temperature is responsible for considerable loss of fluid in the form of sweat, which has to be made good by *rectal and intravenous infusion* of 5 per cent. glucose in distilled water. The glucose is required to replace the vast quantities utilised as a result of the enormously increased basal metabolic rate. The amount of chloride lost in the sweat makes it desirable to substitute 2 pints of normal saline for the 5 per cent. glucose after each 4 pints of glucose solution. Ten to 12 pints of fluid should be delivered in the twenty-four hours. The amount of Lugol's iodine given per rectum may be increased up to 120 minims in the first twenty-four hours, or the addition may be made to the intravenous glucose solution in the proportion of 15 minims to each pint. If the rectum will not tolerate the iodine in saline or glucose solution, then it should be given in 2 oz.

of mucilage. It is inadvisable to exceed 120 minims of Lugol's iodine, because when the limit of tolerance has been reached, no further desirable effect is obtained by giving more, and undesirable skin reactions and other symptoms of iodism may appear.

Should the over-taxed heart show signs of failing and *especially if* cyanosis appears, then *oxygen* is required. This should be given by an intranasal catheter or catheters attached, if possible, to a pair of Tudor Edwards' spectacles and the tap on the cylinder adjusted so that 4 litres are delivered each minute. The oxygen should be bubbled through warm water to minimise the irritation to the nasal and respiratory mucous membrane. Alternatively the B.L.B. mask or the oxygen tent may be used. The old-fashioned procedure of reopening the wound and washing it with saline is based on a wrong conception of the pathology of post-operative thyrotoxicosis and is now no longer practised.

Auricular Fibrillation

A varying proportion of thyrotoxic patients suffer from auricular fibrillation. Joll (*Diseases of the Thyroid Gland*, 1932, London) was of the opinion that this complication is an indication for thyroidectomy before any specific steps are taken, other than the routine pre-medication for such cases, to restore a normal heart-rhythm. If the fibrillation has been persistent, there is a reasonable chance that normal rhythm will be established within three or four weeks after the operation ; if the fibrillation has been intermittent, then the disappearance of this symptom is almost certain as a result of thyroidectomy. The procedure to be adopted is to wait for seven days after the operation to see if the fibrillation will be arrested spontaneously. Should digitalis have been given pre-operatively then the same dose is continued after the operation. On the seventh day, if the fibrillation is persisting, the digitalis is stopped and the patient is given a test dose of 1 grain, and a second test dose of 3 grains of *quinidine sulphate*. If, by this means, it is shown that he is not " quinidine sensitive ", and there is no dizziness, vomiting, abdominal pain or increased fibrillation, he is given 5 grains of *quinidine sulphate* twice on that day. During the succeeding seven days the dose is increased up to 5 grains six times a day, by which time the majority of patients will have stopped fibrillating. If not, a similar week's course of *quinidine sulphate* is given after a rest of three days, starting with 5 grains twice a day and working up to 5 grains six times a day. Exceptionally a third course is required after a further interval of three days. As soon as normal rhythm has been restored, a

maintenance dose of 5 grains of *quinidine sulphate* is given twice a day for four weeks. Occasionally a heart which has been beating with a normal rhythm before operation will start to fibrillate after thyroidectomy. This complication is not serious and the rhythm is restored spontaneously within a few days.

Damage to the Recurrent Laryngeal Nerves

This serious accident occasionally occurs during the course of the operation of thyroidectomy. Damage to *one recurrent laryngeal nerve* causes little disability apart from a varying degree of hoarseness which often clears up spontaneously, but *bilateral recurrent laryngeal palsy* is a tragedy which must be averted by the most careful operative technique. It must be remembered that one nerve may be paralysed before the operation by pressure from the enlarged thyroid or by involvement in a carcinoma. If one nerve is affected in this way it is usually the left, which takes a longer course round the arch of the aorta and is more susceptible to damage. As the unilateral lesion may be symptomless, it is advisable to make a laryngoscopic examination before the operation so that, if the condition is observed, even more scrupulous care should be taken, if that be possible, to avoid damaging the intact nerve.

The symptoms of bilateral recurrent nerve palsy are respiratory obstruction and inability to phonate. The respiratory obstruction in an *incomplete bilateral palsy* will require *tracheotomy* owing to the adducted position of the vocal cords, and this should be performed as soon as the respiratory distress becomes evident and after the diagnosis has been confirmed by laryngoscopy. The signs of cyanosis and retraction of intercostal spaces during inspiration should not be waited for. Later on an operation may be considered to free the nerve from scar tissue or to execute a plastic repair on the cords themselves. Needless to say, these operations hold out but a slender chance of success. In a *complete bilateral palsy* the cords are not adducted, but assume the cadaveric position midway between abduction and adduction. *Aphonia* is complete, but there is rarely any respiratory distress. The treatment is likewise operative, and can be undertaken many months after the original operation. Great care must be exercised in feeding these patients, because recurrent nerve palsy may produce anæsthesia of the larynx (despite the usual anatomical description accounting for the sensory supply from elsewhere) and inhalation of fluids is to be guarded against. Rectal or intravenous feeding may have to be substituted for oral feeding on this account.

Hæmorrhage

Bleeding after thyroid operations is sometimes troublesome and, if the field of the operation has not been adequately drained, may lead to acute respiratory obstruction which demands immediate reopening of the wound and evacuation of the blood which has collected. If both deep and superficial planes have been drained, this accident should not occur, and if bleeding takes place the blood readily escapes. General measures such as morphia injection, the application of ice-bags to the part and propping the patient up with the head of the bed blocked, may serve to control the hæmorrhage. If, however, it persists, the patient must be taken back to the theatre and the bleeding point looked for and ligatured or stitched. A transfusion may be necessary when the bleeding has been controlled.

Tetany

This rare complication of thyroidectomy is due to damage to the parathyroid glands. Its onset is heralded by "pins and needles" and stiffness of the forearms and hands. In the fully developed state the hands go into spasm in the *main d'accoucheur* position and this may be induced in a case of latent tetany by pressure applied round the forearm (Trousseau's sign). Tapping the facial nerve may produce facial spasms (Chvostek's sign).

Five c cm. of 10 per cent. *calcium gluconate* should be injected intravenously twice daily until the symptoms disappear. If after ten days symptoms still persist, then 15 grains of *calcium lactate* may be given by the mouth three times daily. *Collip's Parathormone* may be given by intravenous injection in doses of 10 units three times a week in addition to the calcium lactate. The condition usually clears up satisfactorily after a variable interval, when the parathyroid tissue resumes its normal activity.

Myxœdema

Following total thyroidectomy and sometimes after the subtotal operation the sloth-like characteristics of myxœdema appear. The patient will put on weight and the metabolic rate will be lowered. These symptoms can be controlled by the dried extract of thyroid taken by the mouth The dose should be regulated according to the needs of the patient, starting with half a grain night and morning. It will probably have to be persisted with indefinitely.

The Wound

Sometimes after thyroidectomy the wound becomes indurated and subacutely infected. The application of kaolin or Antiphlogistine poultices four-hourly usually causes this to resolve without suppuration.

The Scar

The scar should be massaged with Vaseline to render it more supple and X-ray treatment may be given any time after the clips have been removed and at least within four weeks, to prevent puckering. In course of time thyroid scars tend to move downwards and may finish over the manubrium. Expensive necklaces should not therefore be ordered to hide the scar until this has settled into its final position after about a year.

II. THE BREAST

Breast Abscess

Although some breast abscesses have been treated successfully by aspiration, I have not found this method as good as incision and drainage. It is possible that aspiration combined with penicillin replacement may prove more satisfactory, but penicillin has not been generally available sufficiently long for this method to have received adequate trial. Hamilton Bailey describes a method of drainage whereby a catheter is inserted through a wide-bore drainage tube and the abscess cavity is irrigated with Dakin's solution. I have had experience of this method in only two cases, so that I am unable to express an opinion on its value, but I suspect that it has not been universally adopted by surgeons because it is little if any advance on the older methods and it requires extra care and attention on the part of the nursing staff.

General Measures

Breast abscesses are liable to recur and to extend in spite of apparently adequate drainage and their management is often disheartening to both doctor and patient. General measures are extremely important and the patient should be nursed as far as possible in the *fresh air*. The *bowels* must have attention, *fluids* should be taken freely, and fruit and fruit-juice are palatable additions to these. If after the abscess has been drained there is still acute toxæmia or spreading sepsis, the patient is given intramuscular penicillin (p. 26) or a course of Sulphathiazole (4 grams a day with a maximum dose of 60 grams) which is

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active against the staphylococcus, the causative organism in the large majority of cases. As soon as the course of Sulphathiazole is finished, natural or artificial sunlight is given to the rest of the body. If given at the same time as this drug, troublesome skin reactions are liable to occur.

Dressings

Locally the abscess is dressed with a kaolin or Antiphlogistine poultice four-hourly and additional heat may be given by means of an electrically-heated pad. If the heated dressings are uncomfortable or cause skin reactions, plain glycerine may be used instead. The drainage tube is gradually withdrawn as the discharge lessens and is moved each twenty-four hours after the first forty-eight. Eventually a smaller tube is inserted and this comes out as the abscess cavity heals. Syringing the abscess cavity with Eusol may help to detach shreds and debris from " Volkmann's membrane " which lines it, but I believe that this measure, which may be painful and disturbing, can readily be dispensed with. Additional rest for the part may be obtained by putting the arm in a sling. The patient is confined to bed until the temperature has been normal for three days and is then allowed up only if she is in hospital or, if in her own home, she can be relied upon to refrain from doing housework or unduly using the arm on the diseased side.

Whether to dry up the Breast

As most of these abscesses occur during lactation the problem as to whether to allow this to continue or not is an important one. If the child is nearing the time when it will be weaned in any case, then no further suckling is allowed from the diseased side and the child is weaned as quickly as possible from the other breast. In the meanwhile the diseased breast is bound as firmly as the inflammation will allow. If weaning has progressed satisfactorily, the patient starts to take a *dose of magnesium sulphate ʒ ij each morning*, whereupon the baby is taken off the breast altogether. Both breasts are then firmly bound. If discharge of milk persists, it may be arrested by taking diethylstilbœstrol 5 mg. daily or some other œstrin preparation such as Menformon (œstradiol benzoate) in doses of 20 mg. per week. If the abscess occurs early in lactation, and this unfortunately is more usually the case, then it is important if possible to preserve this function of the breast. With an abscess situated well away from the nipple, suckling may continue on the diseased side if it is found that the milk from this breast does not upset the baby. A bacteriological examination of the

milk, where this can be rapidly performed as in a hospital, may prevent the more drastic physiological experiment being performed on the baby. If the abscess is discharging near to the nipple, then suckling will be impossible and the nipple should be carefully cleansed and the milk drawn off with a breast-pump. Bacteriological examination may reveal the unsuitability of this milk as a food; but if not, small doses can be given to the baby, and if he is not upset the whole of the milk drawn off from the diseased side may be fed to him. If the progress of the abscess is unsatisfactory with this regime, then the baby will have to be weaned and the breast secretion dried up as described above.

Prognosis

Disappointments and delays must be expected in this condition where the infection burrows deeply into the breast-tissue or where fresh foci form, and the patient should be forewarned of this. Rarely the condition progresses to staphylococcal septicæmia and the patient may die of suppurative pericarditis or multiple abscesses in the lungs.

Partial or Total Mastectomy

These operations require no special after-treatment. Drainage tubes are withdrawn in forty-eight hours, and the part is firmly bandaged with crêpe bandage passing round the chest to prevent hæmatoma formation and the collection of serous material. The danger of chest complications following this operation is negligible.

Radical Mastectomy

The Skin

This operation is performed for carcinoma of the breast and requires therefore wide removal of skin. Because of this it may not be possible to bring the skin edges together after the operation, and it is no reflection on the skill with which this operation has been performed if the patient returns to bed with a large raw area uncovered by skin. Interrupted salmon-gut stitches are best in these cases, as they have the least deleterious effect on the skin edges which may be of doubtful viability. On the other hand they take very much longer to put in than Michel clips, and this, at the end of a long operation, may be an important consideration. Consequently I have found it best to use Michel clips at the ends of the incision where there is usually no tension and salmon-gut sutures in the middle where the tension is greatest. In addition, four or five tension sutures threaded through an inch of

capillary tubing help to hold the incision together in the middle. An important point to remember in this connection is that if, in an endeavour to bring the skin edges together, too great a tension is exerted and part of the skin sloughs, then healing of the raw area is at least twice as long as if the skin had not been completely brought together in the first place. If, therefore, on examining the wound after forty-eight hours, at which time the drainage tubes are removed wholly or in part, it seems that the skin is likely to slough, there is still time to save it by removing stitches and allowing the wound to gape. Skin which is in danger of sloughing will look purple and bruised, and if the tension is released it is still in a state capable of recovery, so that some weeks may be saved by the removal of a few stitches at this stage.

The raw area left as a result of being unable to bring the skin edges together may sometimes be grafted at the time of the operation, but more commonly it is not so extensive as to make this worth while. The area can be dressed with sponges soaked in Eusol and, when granulations have formed and are clean, zinc and castor-oil ointment or "scarlet ointment" may be substituted. Alternatively the area may be skin-grafted at this time.

Drainage Tubes

Long drainage tubes are used after this operation because of the tendency for oozing to occur from the raw surfaces. The upper ends of these drains are in contact with or adjacent to the axillary vein and brachial plexus. It is most important that they should be shortened in forty-eight hours, because prolonged contact with these structures may lead to axillary vein thrombosis and pulmonary embolism on the one hand or brachial neuritis on the other. If they cannot be completely removed after forty-eight hours, they can be taken out with perfect safety on the following day.

Position of the Arm

The position of the arm after operation is important, as there is always some limitation of extreme abduction. After radical mastectomy this limitation may be serious unless steps are taken to prevent it. On recovery from the anæsthetic the arm is nursed on two pillows in 70° of abduction. Movements of the fingers, wrist and elbow start at once and movements of the shoulder-joint begin when the drains are removed on the third day By the end of four days the patient should be able to touch the ear on that side with the head erect, by the end of seven days she should be able to touch the back of her head and do her hair, and by the end of ten days she should reach the

opposite ear. Needless to say the incision must be planned so that a fold of scar-tissue like a web is not left running across the axilla binding the arm to the side.

Prevention of Serous Collections

The gain in freedom of movement of the arm accruing from nursing it in abduction is so great that it outweighs any disadvantages of the method. On the other hand it means that there is a tendency for a free space to form in the axilla where serous fluid collects. Apart from the danger of this collection becoming infected, its organisation is attended by such a degree of fibrosis as to cause in many cases brachial neuritis or severe œdema of the arm. To prevent this I use a " snowball " of cotton-wool pressed into the axilla over the dressings and bound firmly in place with crêpe bandage. The snowball is retained for a week, by which time the integument has become firmly adherent to the chest wall in the region of the second rib and there is no danger of this space appearing. The striking infrequency with which chest complications follow even a radical mastectomy allows crêpe bandage to be applied in this way without danger.

Deep X-ray Therapy

There has been controversy about the value of post-operative deep X-ray therapy in these cases, and one well-known surgeon with extensive experience of this operation does not advise it on the grounds that it upsets the patient's general health upon which her defence against stray cancer-cells left behind after the operation largely depends. His results are as good as any that have been published or better, but I prefer to think that this is due to the excellence of his technique. If deep X-ray therapy is deleterious in this way—if, that is, its beneficial effect in killing the cancer-cells is outweighed by its damaging effect on the general health—then this argument can be applied to deep X-ray therapy for malignant disease in general and such a *reductio ad absurdum* would be untenable. Most surgeons advise post-operative deep X-ray therapy, and this should be started, if the patient is in a hospital where it is available, as soon as the tension stitches have been removed on the tenth day, provided that the wound has healed ; or, if a raw area has been left, when epithelialisation of this is well advanced. Deep X-ray therapy will indeed delay the healing of this area, but I believe its effect to be so desirable that it is not advisable to delay giving it until a raw area has completely healed. If the patient is not in a hospital where X-ray therapy is available, then this should be started as soon as she is fit to visit such a centre.

Complications

Complications, apart from recurrence, follow this operation very rarely. The most serious are those resulting from fibrosis in the axilla, namely, brachial neuritis and œdema.

Brachial neuritis in a mild form is common after many radical mastectomies, but this usually resolves spontaneously, although it may mean that the arm must be rested in a sling and this is apt to lead to some permanent impairment of abduction. If the neuritis persists, it may be due to deposits of new growth in the axilla, but even if the cause is a benign fibrosis it is extremely intractable and may resist all forms of treatment. On one occasion I injected alcohol intrathecally opposite the brachial enlargement of the spinal cord for this complaint, but although cutaneous anæsthesia was produced, there was no alleviation of the neuritis. The arm must be rested in a sling and radiant heat may serve temporarily to alleviate the distress, but often morphia will be required.

Œdema is a very troublesome complication and like brachial neuritis, with which it may be associated, is due either to neoplastic deposits or to fibrosis within the axilla. Œdema due to neoplasm often comes on months or even years after the operation. When it is due to fibrosis the swelling of the arm is noticeable in a matter of days or weeks. Treatment is first of all by posture, and elevation of the arm on two pillows or supporting it from a rail over the bed usually causes the swelling to subside. If the patient is up, the arm must be supported in a sling and, if the skin will take it without becoming irritated, an Elastoplast bandage may be applied from the heads of the metacarpals to the top of the arm. Œdema from neoplasm in the axilla is likely to become progressive and the condition must be treated palliatively. In very resistant cases due to benign fibrosis the operation of lymphangioplasty has been tried, but the benefits of this operation are unlikely to be permanent.

Recurrence

Recurrence may appear in the skin around the incision, in the opposite breast, in the skeleton (especially the spine and the upper end of the femur), in the lungs or liver as well as in the axilla or supraclavicular fossa. These recurrences except along the incision and in the opposite breast cannot be actively treated. The patient must be made as comfortable as possible in mind and body and should on no account be allowed to suffer pain *Deep X-ray therapy to skeletal deposits* undoubtedly alleviates pain and should be given to the spine

or long bones. If a deposit occurs in the spine, this may be either osteolytic or osteosclerotic. The former is the more common, and although severe *root-pains* are usually the only symptom, *pathological fracture* may occur. In order to prevent possible fracture it would be necessary to confine a patient with spinal deposits to bed, but these patients have so little active life before them that it would be unfair to adopt this course and deprive them of what little enjoyment may be left. If pathological fracture occurs, it is a compression fracture and does not usually involve the spinal cord. Pain is the one indication for putting these patients to bed and then only so that full doses of morphia (p. 5) may be prescribed. A second operation may always be considered for local recurrence and for a recurrence in the opposite breast. Suitability for further operative treatment obviously depends on the absence of deposits elsewhere. It must be remembered that a fresh carcinoma may arise in the remaining breast, so that the prognosis is not necessarily so hopeless as it might at first sight appear.

Prognosis

The prognosis in carcinoma of the breast subjected to operation (excluding those cases where there is adherence to chest wall, extensive skin involvement or widespread metastasis) depends on whether there are deposits in the axillary glands. There is a wide variation in reported series, but it would be roughly true to say that if the axilla is free from involvement, not only clinically but microscopically, then there is an 80 per cent. chance of a five-year survival. If the axillary glands are involved, there is only a 20 per cent. chance. Five years is taken in gauging survival-rates, because if the patient has remained free up to this time recurrence is unlikely.

Relation to Trauma

Occasionally the doctor will be asked whether the carcinoma has been caused by a blow and he may even be required to give evidence in a court of law on this point. The scientific answer is that we do not know and evidence is notoriously hard to collect. In law a patient may claim and be awarded damages only if the trauma was of such a degree as to be remarked upon at the time or to have produced symptoms of pain or signs of hæmatoma; also if the neoplasm develops at the exact site of this trauma and if it appears within six months to a year.

CHAPTER V

THE CHEST

I. THE LUNG—POST-OPERATIVE COMPLICATIONS

SYMPTOMS referable to the chest are frequent after most operations. Post-operative chest complications although generally trivial may have the most serious consequences and they are all too often regarded as an unavoidable incident for which an expectorant mixture may be prescribed. As Brock remarks in a valuable article (*Guy's Hosp. Rep.*, 1936, 86, 191), from which much of the material for this section is derived, " It is illuminating, but at the same time disturbing, to see a bout of fever associated with a productive cough dismissed as a ' chest ' rather in the same fatalistic spirit as a wet day on a summer holiday is regarded—a disappointing and vexatious visitation that just has to be accepted." This attitude must be exorcised, and the doctor should come to regard these complications as, in a measure, a reflection on his care of the patient. Patients die of post-operative chest complications, and this may be unavoidable, but I believe that more die than should.

Chest complications are more common in *old patients* and they are especially liable to follow *operations on the abdomen and for hernia.* They occur with almost equal frequency throughout the seasons and some of the most severe cases may be met with during a heat-wave. *Men* are more prone to them than women. Pre-existing *infection of the upper respiratory tract* is a most fruitful source of post-operative chest trouble. Bronchitis, a slight cold and a " relaxed " throat are all absolute contra-indications for the performance of an operation other than in an emergency. The old-fashioned *" many-tail " bandage*, by restricting the free movements of the chest, is undesirable and a corset made of strapping is to be preferred for abdominal incisions. Inhalation anæsthesia is not associated with a markedly higher incidence of chest complications than spinal anæsthesia. Local anæsthetics, although by no means immune from this complication, probably give rise to slightly fewer chest affections than inhalation or spinal anæsthesia

Bronchitis

Perhaps in an endeavour to dissuade students from making the too easy diagnosis of bronchitis, many workers who have paid particular attention to this subject tend to belittle the frequency of this complication as compared with the more serious affections. Certainly nothing could be more slovenly or less helpful to the patient than that attitude of mind which labels all mild post-operative chest complications which clear up quickly as " bronchitis " and all the more severe ones which take longer to clear up as " pneumonia ". Nevertheless bronchitis occurs with some frequency after operation. It can be recognised by a slight fever, and a mild productive cough which appears usually within a few days of the operation. On physical examination râles can be heard at one or both bases. This condition usually resolves spontaneously but may be the precursor of more serious complications.

Treatment

It should be treated by attention to the freedom of movement of the chest. The patient should not be allowed to " flop " in bed but should be propped up. Constricting dressings should be loosened or adjusted and the patient should be encouraged to cough up the sputum by leaning over first towards one side of the bed and then the other. Potassium iodide gr.v may be prescribed three times a day, and, if it is available, the inhalation of 30 per cent. carbon dioxide for five minutes each hour may aid the ventilation of the lungs. If there is an indication for it from other considerations, morphia need not be withheld. Often the depth of respiration is increased by freeing the patient from the pain and anxiety of the respiratory excursion in the presence of an abdominal wound. *Breathing exercises* are the most valuable feature of the treatment. If possible they should be carried out under supervision and, where symptoms are confined to one side, this side should be exercised particularly by forcible restraint of the unaffected side during deep respiration. Pre-operative breathing exercises should have been prescribed as a routine to middle-aged patients, particularly men, about to undergo an abdominal operation. Inhalation of the vapour from a solution of Tinct. Benzoin. Co. (ʒi to a pint of hot water) is often soothing and helps to loosen the cough.

Atelectasis

Pathology

By far the commonest post-operative chest complication is due to a collapse of part of the lung substance. This collapse follows obstruc-

tion to the bronchus or bronchiole feeding the part, at least so many authorities believe. Certainly the collapse is associated with bronchial obstruction and can only be overcome by relieving the obstruction. Furthermore it can be prevented to a large extent by treating those factors which produce bronchial obstruction. The collapse may affect a variable volume of the lung tissue ; it is often patchy and does not necessarily confine itself to the boundaries of the lobes. Sometimes the whole of one side of the chest will collapse, sometimes a whole lobe and sometimes the areas are so small that there is difficulty clinically in distinguishing it from bronchitis.

The cause of bronchial obstruction is obscure and probably many factors are involved. The obstructing agent is usually a plug of inspissated mucus. Certainly bronchial infection by the production of purulent secretion into the bronchioles is a most important factor, and that is why the occurrence of a simple bronchitis after an operation is not a complication to be regarded lightly. As can be seen, all the measures adopted in the treatment of bronchitis are directed towards increasing the ventilation of the lungs and the expectoration of bronchial secretions. Treatment of bronchitis is in fact intended to prevent the bronchi becoming obstructed and is prophylactic against atelectasis. Restriction of chest movement by bandages and " floppiness " in bed are again factors in allowing secretions to accumulate. The prescription of atropine pre-operatively has been indicted as a factor in drying the secretions and rendering them more tenacious and more difficult to cough up. Certainly over-dosage with atropine should be avoided and atropine should not be prescribed post-operatively, but the benefit at the time of the operation from pre-medication with this drug is out of all proportion to the possible influence it might exert later in the production of atelectasis.

THE CLINICAL ASPECT

Clinically pulmonary atelectasis is usually easy to diagnose. The condition comes on within forty-eight hours of the operation and is characterised by a simultaneous rise of temperature, pulse- and respiration-rate to considerable heights within the space of a few hours. The temperature may rise from 99° F. to 105° F., the pulse-rate from 100 to 180 and the respiration-rate from 20 to 50, all in about six hours. This gives a characteristic chart (Fig. 10) and often allows the condition to be diagnosed from the end of the bed. Pain may be complained of in the chest, but it is not a marked feature of the condition. Respiratory distress, anxiety and cyanosis are common. On examination there is diminished movement of the chest wall over the collapsed part

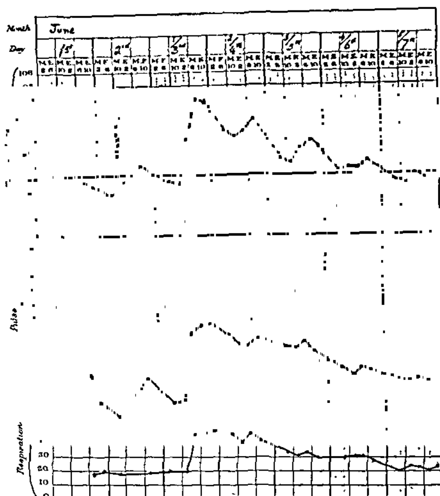


FIG. 10 —Chart in a case of atelectasis, showing simultaneous rise of temperature, pulse- and respiration-rate

of the lung and dullness to percussion On auscultation a variable effect is obtained. If the main bronchus to a collapsed area is patent and acting as a conduit for air, then the collapsed lung, being an increased conductor of sound, will give bronchial breathing and increased voice and breath sounds ; if, on the other hand, the main bronchus supplying the part is itself obstructed, then there will be absent breath and voice sounds (Fig. 11). A feature of the condition is the rapidly changing auscultatory effects so that an area which failed to conduct at one moment gives bronchial breathing the next and *vice versâ*. Where the effects of atelectasis are not widespread the clinical picture may not be so striking and it may be impossible to distinguish the condition from a simple bronchitis. The differential diagnosis in these mild cases of atelectasis is not important in that, as we have seen,

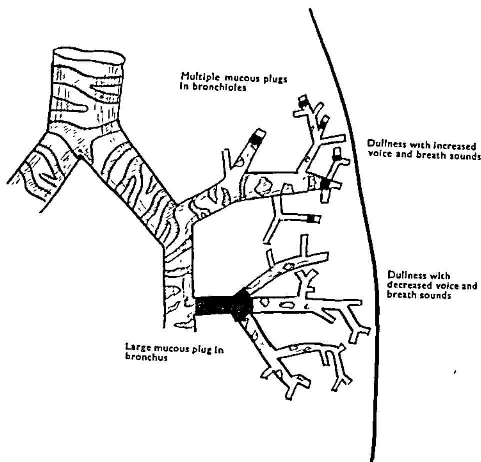


FIG 11.—Diagram to show the mechanism of increased and diminished breath sounds in atelectasis.

the treatment for bronchitis is prophylactic for, and in fact practically identical with, that of atelectasis.

TREATMENT

The importance of recognising the more massive cases of atelectasis for what they are lies in the prognosis. Massive atelectasis, despite its alarming picture and the distress and anxiety which accompany it, is a condition which carries a good prognosis when adequately treated. Once the patient can be induced to expectorate, the condition very rapidly subsides and he makes a complete recovery. The treatment is similar to that described for post-operative bronchitis with certain modifications. It is necessary to localise the area of collapse and an X-ray examination of the chest is essential. Treatment should then be directed particularly towards this part of the lung. *Breathing exercises* must be controlled so that the whole of the respiratory effort

is concentrated on the collapsed area, and this can most readily be effected by the aid of a masseuse who restrains the movements of the normal lung. *Posture* must be adjusted so that the obstructed bronchus can empty itself of its secretions without having to compete against the full effects of gravity. Without overtaxing him and within the dictates of common sense, the patient can lie with his head and shoulders dependent over the side of the bed, the collapsed side uppermost, and in this position pressure on the affected part during expiration may enable him to dislodge the obstructing mucus. This exercise may be undertaken two or three times during the course of the day. If the collapse is bilateral the patient should lie first on one side and then on the other. *Potassium iodide* and *carbon dioxide inhalation* are useful adjuncts to this treatment, and are prescribed as in the treatment of bronchitis. Sulphonamides may be prescribed if the temperature fails to settle in 72 hours, whilst for the more severe cases some surgeons advocate aspiration of the mucous plug by means of a bronchoscope.

Pneumonia

The Clinical Aspect

Exceptionally atelectasis may make its appearance late in the postoperative period, but a chest complication arising after the third or fourth day is almost certainly not an atelectasis. The appearance of pyrexia, a rapid pulse, a raised respiration-rate, a productive cough and patches of consolidation of the lung at this time in the postoperative period are most often due to a pneumonia. This pneumonia may have arisen in areas of atelectasis, and for this reason energetic treatment of the early symptoms of chest complications is important. In *broncho-pneumonia* the rise in temperature is not so sudden as in atelectasis, though equally high levels may be reached, and the parallelism between this rise and that of the pulse- and respiration-rate is not quite so striking. This together with the later onset of the condition should serve to distinguish it from a simple collapse. Though the symptoms and signs of broncho-pneumonia are not so dramatic as those of atelectasis, the prognosis is much worse. Pneumonia is apt to arise in debilitated and feeble subjects, and is responsible for a large percentage of fatal chest complications.

Treatment

Although the treatment is along the same lines as the two foregoing conditions, it cannot be so energetic because of the weak state of the

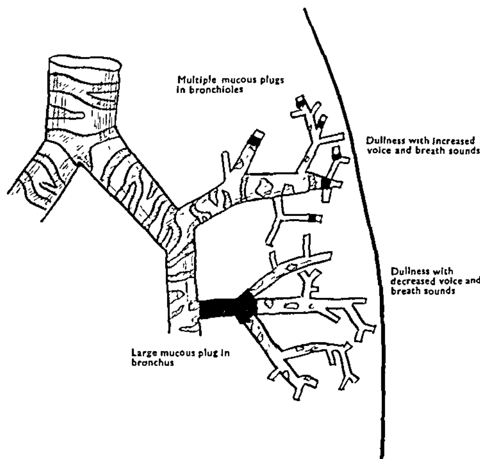


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and a bacteriological examination of the sputum for tubercle bacilli should be made.

Acute Pulmonary Œdema

This name has been given to a well-recognised condition which complicates left-sided heart failure and poisoning with phosgene gas. It is characterised by a raised temperature, and raised pulse- and respiration-rate; intense water-logging of the lungs, cyanosis and the appearance of rose-coloured froth at the nostrils and the mouth. This syndrome may appear on rare occasions after operation and then generally only with left-sided heart failure. The prognosis is very poor, but postural drainage may help to get rid of some of the excessive secretions, an injection of atropine (gr. $\frac{1}{60}$) should be given and oxygen is required for cyanosis. Excessive secretion from the bronchi tending to produce patchy atelectasis by obstruction is, however, a common post-operative complication and is familiarly termed "pulmonary œdema" because it is often associated with œdema of the loins, ankles and elsewhere. It is doubtful, however, if this has the same significance as the syndrome described above and further research will probably separate these "watery conditions" of the lung.

An important factor in producing "pulmonary œdema" of this type is excessive administration of fluid by the intravenous route, particularly an over-dose of chloride. The principles of fluid administration are fully discussed on p. 10, and if these principles are observed, water-logging of the chest should not occur. The symptoms are those of an early bronchitis or atelectasis with excessive moist crepitations and bubbling heard particularly over the bases. Intravenous infusion is stopped or, if absolutely essential, the volume given is considerably reduced and the treatment described for pulmonary atelectasis instituted. Atropine, however, is not given in these cases because, whereas in the fearsome syndrome described above, the patient is in imminent danger of drowning, here the danger is more of bronchial obstruction and atelectasis which atropine would be likely to encourage.

Subphrenic Abscess is dealt with in the chapter on residual abscesses (p. 120) and **Pulmonary Embolism** is discussed on p. 104.

II. THE PLEURA—EMPYEMA

The presence of pus in the pleural cavity is diagnosed when there are signs and symptoms of fluid in the chest, together with the swinging temperature, rapid pulse and other toxic manifestations of imprisoned pus. The diagnosis is confirmed by aspirating some of the fluid.

patient and the serious nature of the condition. Early on *postural drainage* is the sheet-anchor of treatment and at least twice a day all the pillows should be removed and the patient should lie first on one side and then on the other and coughing should be encouraged. Manipulations of the chest should be practised only with the greatest care and later when exhaustion appears they are better avoided. In the fulminating stage of the disease movement is forbidden and breathing exercises lying flat on the bed must be discontinued. All that can be done is to see that no constricting influences hamper the movements of the chest and that the patient's strength is maintained. Sulphonamide or penicillin therapy is of value at this time and *oxygen* may be necessary when there is cyanosis. A true lobar pneumonia is exceptionally rare after operation.

Lung Abscess

This complication may be due to the aspiration of a foreign body or foreign material at the time of the operation, it may complicate an unresolved atelectatic area or it may follow a septic infarct. The symptoms are usually late and often come on after two weeks. The condition is distinguished from atelectasis by this late incidence and by the gradual onset of symptoms. From post-operative pneumonia (which as mentioned above is practically never of the lobar variety) it can be diagnosed by the localised signs of consolidation, the intense toxæmia and the foul breath and sputum. Usually the pleura becomes involved early and an empyema develops. An X-ray examination will confirm the diagnosis and is necessary to localise exactly the site of the abscess. The treatment of this complication must always be undertaken in conjunction with the surgeon. In broad outline the more centrally placed abscesses are treated posturally and by bronchoscopic aspiration; those more peripherally placed, and essentially those in which there is pleural involvement, by drainage from the surface in one or more stages.

Phthisis

This condition must always be borne in mind in obscure and obstinate chest infections. *Anæsthetics* are liable to light up quiescent foci in the lungs and the disease may pass unrecognised simply because, in these circumstances, it is just not thought of. Patients with *peptic ulcer* are notorious deceivers in this respect, and whenever there is any doubt about the possibility of phthisis, wherever there is a suggestive diathesis or a family history, then an X-ray examination of the chest

be displaced, a state of affairs which can be confirmed radiologically.

(4) To overcome toxæmia.

(5) To introduce penicillin.

In most cases where the mediastinum is not grossly displaced and where there is only moderate toxæmia, aspiration can be performed every third day. A specimen is sent for bacteriological examination and the remainder is evacuated into a test-tube which is placed in a rack over the patient's bed. At the conclusion of the aspiration, if the organism is sensitive, penicillin solution (1,000 units per c.cm.) is injected into the cavity. For a "total empyema" 120 c.cm. are required, in a moderate-sized cavity 60 c.cm. and for smaller loculated cavities 30 c cm. When the cavity is so small that less than 50 c.cm. can be aspirated, penicillin solution in quantities equal to half the volume of aspirated fluid may be injected. This measure renders the empyema cavity free from gram-positive organisms. It is still too early to say how it will affect the necessity for subsequent surgical procedures. Reports up to the present time indicate that these will still be required, although the lessened infection leads to less fibrin deposit, more rapid expansion of the lung and quicker healing. As time goes on the aspirated pus will be thicker in consistency and the sediment which settles in succeeding specimens will constitute a greater proportion of the whole. Assessment of this proportion, as will be seen, has an important bearing on deciding when to perform the operation of rib-resection.

Aspiration can usually be proceeded with until the indications for rib-resection obtain (*vide infra*). If, however, there is so much mediastinal shift as to cause distress and the cavity refills rapidly after aspiration, or if the aspirated pus is very foul and the patient acutely toxic, then this aspiration must be performed more frequently. The pain and distress of repeated aspiration can be mitigated to a certain extent by making a small incision over the site of election and packing this open with a dressing soaked in Eusol or acriflavine.

Intercostal Drainage

Some surgeons practise intercostal drainage as a routine instead of repeated aspiration. This consists in thrusting a trocar and cannula through an intercostal space under a local anæsthetic; the trocar is removed and a self-retaining catheter of the Malecot pattern is passed through the cannula, the latter being withdrawn over the catheter. The end of the catheter is then connected to a rubber tube leading to an

Apart from tuberculous empyema, and with very few other exceptions, adequate drainage of an empyema cavity can only be obtained by the removal of a short length of rib over the cavity and the insertion of a wide-bore drainage tube through the resulting defect in the chest-wall.

Management before Rib-resection

The patient's sputum is examined bacteriologically, especially for tubercle bacilli, and X-ray photographs are taken at weekly intervals. A course of sulphonamide therapy is instituted, but parenteral penicillin is of value only in the early acute stages and when the empyema appears at the same time as a pneumonia (synpneumonic empyema). Sulphonamides should be stopped as soon as adequate drainage is afforded by rib-resection.

It is important that rib-resection should be performed at exactly the right time. If it is done too early the abscess will not have been properly walled off and the effect of opening the pleura will be to allow the lung to collapse and the whole pleural cavity will be infected, resulting in the condition of pyo-pneumothorax; or in a big empyema cavity, the mediastinum will not have become fixed and exposure of one pleural cavity to atmospheric pressure may produce a shifting of the mediastinum with disastrous consequences. On the other hand, if drainage is undertaken too late, then the walls of the abscess cavity will be so thick and tough that they will not collapse and allow the abscess to be obliterated by expansion of the underlying lung. It is necessary therefore to select a time when the abscess has become localised but when the walls are still thin and pliable.

Aspiration

Before discussing the indications for rib-resection we shall consider the management of a case of empyema in the preliminary stages which lead up to this operation

An empyema is aspirated:

(1) To establish a diagnosis and for bacteriological examination of the fluid.

(2) To assess the consistency of the pus

(3) To replace a mediastinum which may be shifted so far over to the opposite side that cardiac and respiratory embarrassment is caused. In this case the trachea may be felt pushed over to one side and the apex-beat and area of mediastinal dullness will

be displaced, a state of affairs which can be confirmed radiologically.

(4) To overcome toxæmia.
(5) To introduce penicillin.

In most cases where the mediastinum is not grossly displaced and where there is only moderate toxæmia, aspiration can be performed every third day. A specimen is sent for bacteriological examination and the remainder is evacuated into a test-tube which is placed in a rack over the patient's bed. At the conclusion of the aspiration, if the organism is sensitive, penicillin solution (1,000 units per c.cm.) is injected into the cavity. For a "total empyema" 120 c.cm. are required, in a moderate-sized cavity 60 c.cm. and for smaller loculated cavities 30 c.cm. When the cavity is so small that less than 50 c.cm. can be aspirated, penicillin solution in quantities equal to half the volume of aspirated fluid may be injected. This measure renders the empyema cavity free from gram-positive organisms. It is still too early to say how it will affect the necessity for subsequent surgical procedures. Reports up to the present time indicate that these will still be required, although the lessened infection leads to less fibrin deposit, more rapid expansion of the lung and quicker healing. As time goes on the aspirated pus will be thicker in consistency and the sediment which settles in succeeding specimens will constitute a greater proportion of the whole. Assessment of this proportion, as will be seen, has an important bearing on deciding when to perform the operation of rib-resection.

Aspiration can usually be proceeded with until the indications for rib-resection obtain (*vide infra*). If, however, there is so much mediastinal shift as to cause distress and the cavity refills rapidly after aspiration, or if the aspirated pus is very foul and the patient acutely toxic, then this aspiration must be performed more frequently. The pain and distress of repeated aspiration can be mitigated to a certain extent by making a small incision over the site of election and packing this open with a dressing soaked in Eusol or acriflavine.

Intercostal Drainage

Some surgeons practise intercostal drainage as a routine instead of repeated aspiration. This consists in thrusting a trocar and cannula through an intercostal space under a local anæsthetic; the trocar is removed and a self-retaining catheter of the Malecot pattern is passed through the cannula, the latter being withdrawn over the catheter. The end of the catheter is then connected to a rubber tube leading to an

empyema bottle under the bed. The precautions to be taken with such an empyema bottle are discussed below under " Closed Drainage ". Penicillin solution is introduced each day through the intercostal tube in the doses described above, and the tube is then clamped off for four hours to allow the penicillin to take effect.

Although drainage by this method is more efficient than with aspiration, there is a moment after the trocar has been withdrawn from the cannula and whilst the catheter is being inserted through it, when the pleural cavity is exposed to atmospheric pressure, and a dangerous swing over of the mediastinum may occur at this time.

There are, however, two definite indications for intercostal drainage :

(1) *Failure of Aspiration*

In even the most severe cases daily or perhaps twice daily aspirations performed as described above will generally control the empyema until such time as rib-resection can be performed. Occasionally with such a regime the patient's condition will deteriorate or it will be impossible to keep the cavity under control as the empyema seems to fill up again almost as soon as it has been aspirated. In these circumstances intercostal drainage may prove a life-saving measure.

(2) *Pyo-pneumothorax*

This condition is manifested by a shifting pleural dullness and a " fluid level " in the X-ray, if this is centred precisely horizontally, or by the appearance of fluid below and pneumothorax above. In an empyema which has not been drained and which has been aspirated with care, such a finding indicates a broncho-pleural fistula. In this case the size of the cavity is not diminished by aspiration, as air leaks in from a bronchus as pus is withdrawn through the needle ; furthermore the cavity is already in communication with the atmospheric pressure through the fistulous bronchus and there is therefore no contra-indication to the better drainage which an intercostal catheter affords. On the other hand, the patient is often too ill to undergo the more taxing procedure of rib-resection.

Rib-resection

When to Resect

Rib-resection is practised as soon as the sediment in the aspirated fluid shows an 80 per cent. deposit after standing for twenty-four hours,

because it is known empirically that by the time the pus has reached this degree of consistency the cavity will be well walled off and the mediastinum fixed. Sometimes, especially in the foul exudate from an empyema cavity in association with a lung abscess, or occasionally in streptococcal empyema, the pus resolutely refuses to thicken. Reliance should then be placed on radiological evidence that the cavity has been walled off and rib-resection practised as soon as this is apparent. Very occasionally, when the pus remains thin and X-rays are not available or are unsatisfactory, the duration of the pleural infection can be taken as an indication for rib-resection. In these circumstances no untoward result need be anticipated if adequate drainage is given to an empyema by rib-resection at the sixth week, and it should be done then.

When intercostal drainage has been instituted the pus is collected in an empyema bottle containing fluid, so that it is not available for putting up in a test-tube. Rib-resection is practised in such cases when the intercostal drainage becomes inadequate. Thus frequent blockage of the intercostal catheter as shown by the absence of the natural rise and fall of the fluid level in the empyema bottle with each respiration ("respiratory swing"), the appearance of thick flocculi in the discharge and the recurrence of an otherwise unexplained swinging pyrexia during the period of recovery are indications for rib-resection and the institution of freer drainage. Except in children it is unusual for an empyema, drained by means of an intercostal catheter, to collapse and heal without rib-resection.

There are two methods of draining an empyema after rib-resection—



Fig. 12—Tudor Edwards' tube.

the "closed" and the "open" method. Closed drainage means that the opening in the chest wall fits so snugly round the drainage tube as to be water-tight, and some drainage tubes, such as the Tudor Edwards' tube, have a double flange to make this junction more secure (Fig. 12).

Closed Drainage

With *closed drainage* it is possible to exert a negative pressure on the abscess cavity by connecting the tube in the chest-wall to another length of rubber tubing passing to a Winchester flask or empyema bottle filled with a deodorant solution under the bed, so that the end of the latter tube is always below the fluid level in the flask. This system will only maintain negative pressure by siphonage when the tube is actually dipping into the fluid in the flask. If for any reason, such as the necessity for emptying the flask and refilling with fresh solution, the tube has to be removed from the fluid, it must first of all be clamped off.

To secure the rapid collapse of the abscess cavity, it is desirable to irrigate this twice daily. In order to do this the Tudor Edwards' tube is fitted with a side tube of narrower bore which is normally shut off by a spigot. To irrigate the cavity the side tube is compressed to prevent air from being sucked into the cavity when the spigot is removed and a loaded syringe is connected. Irrigation should be continued until flakes of inspissated pus cease to appear in the washings which escape down the main tube. In the first instance normal saline should be used for washing out the cavity until it is quite certain that a broncho-pleural fistula is not present (*vide infra*). Later, Dakin's solution may be used as it has a disintegrating effect on fibrin and helps the cavity to collapse more quickly. Dakin's solution, however, must not be used in the presence of a broncho-pleural fistula, because it causes such a quantity of foam that this may surge up through the fistula into a bronchus and drown the patient. At the conclusion of the irrigation, penicillin solution may be injected into the cavity as described above ; but if this is done the previous irrigation will have to be with saline only as Dakin's solution destroys the penicillin Where there is much fibrin it would be better to use Dakin's solution and forgo the penicillin.

Open Drainage

In the *open method* no precautions are taken to secure a water-tight junction between the drainage tube and the chest-wall and any wide-bore rubber tube may be used for the purpose. Negative pressure cannot be maintained by this method, but irrigation can be practised through the drainage tube.

It is obviously an advantage to accelerate the collapse of the abscess cavity by means of negative pressure, and consequently, if a side tube is provided for irrigation, the closed method is to be preferred. On the other hand closed drainage of an empyema cavity necessarily

means that the patient is confined to bed and the benefit of lung expansion which follows the ambulatory treatment of such cases is not obtained. In the majority of cases two factors resolve the problem in an eminently satisfactory way. The first is that immediately following the drainage of an empyema cavity and for the ensuing six or seven days, until the temperature has settled, the patient must be confined to bed. The second is that a drainage which is "closed" at first, becomes "open" in the course of about a week because the tube works loose and the joint between it and the chest-wall ceases to be water-tight. In practice therefore the benefits of both methods are obtained. For about a week the patient is confined to bed with a closed drainage system siphoning into a flask underneath the bed. At the end of this time, just as the system is beginning to fail because of leakage around the drainage tube, the patient is fit to start getting up and the Tudor Edwards' tube is removed and open drainage substituted.

Later Management

As soon as possible after the operation, breathing exercises are begun in order to expand the lung and hasten the collapse of the cavity. These may be undertaken by the patient himself after instruction, but are best conducted by a masseuse or nurse who will hold the sound side of the chest firmly between her hands and instruct the patient to breathe deeply. By controlling the excursion of one side in this way the affected side will expand to a greater extent. These exercises should be undertaken once or twice each day, and in the meantime the patient may amuse himself with some profit by blowing through Woulfe bottles and inflating toy balloons. If the case seems to be "hanging fire", then a period of nursing in the fresh air on a balcony or in a garden may prove to be the turning-point.

At the time of substitution of open for closed drainage it will be advisable to discover *the size of the cavity*. This can be done with accuracy by filling the cavity with radio-opaque material and X-raying the chest. Such a degree of precision is, however, unnecessary and the method is expensive. A sufficiently accurate picture may be obtained by measuring the volume of Dakin's solution or saline required to fill the cavity to overflowing.

Removal of the Tube

The doctor's next concern is when to remove the tube. Much harm comes from removing the tube too soon, less harm from leaving it too long. The tube should be removed when the cavity has become obliterated and this is shown by the decreasing volume of solution

which the cavity will accommodate. A final assessment of collapse can be made relatively inexpensively by filling the now tiny cavity with Lipiodol and X-raying the chest.

Complications

The only serious complication peculiar to an empyema is a *chronic empyema sinus.* This may be due to several causes.

(1) *Broncho-pleural Fistula.*—A simple empyema may communicate with the bronchial tree, but this complication is more common when the empyema is secondary to a lung abscess or a carcinoma of the bronchus. The condition may be recognised by the appearance of bubbles of air in the empyema bottle on deep respiration or coughing, and by the patient complaining of a taste of Dakin's solution should this solution have been inadvertently used to wash out the cavity, and may be proved by the appearance of methylene blue in the sputum after this has been introduced into the empyema cavity, or more elaborately by injecting Lipiodol into the bronchial tree and finding on X-ray examination that this has leaked into the cavity.

If the empyema is a simple one no untoward effect may be looked for from this complication other than delay in closure of the fistula, which will eventually take place spontaneously. If, on the other hand, the empyema is secondary to a carcinoma of the bronchus, the prognosis is practically hopeless and the treatment of such a condition does not come within the scope of this book. The possibility of such a condition should always be borne in mind when an empyema occurs spontaneously in a patient of the cancer age and a careful examination will probably reveal the diagnosis.

(2) *Delay in Draining the Empyema and Too Early Removal of the Tube.*—Both these errors lead to imperfect collapse of the abscess cavity from thickening of the walls which may become cartilaginous in consistency. An attempt may be made to dilate the sinus and re-insert a rubber tube through which the cavity can be irrigated with Dakin's solution and the regime described above instituted, but more often than not a thoracoplasty will be called for to enable the cavity to collapse.

(3) *Retained Foreign Body*—Drainage tubes have slipped into empyema cavities in the past and no doubt will do so in the future. They should of course be secured by a transfixing safety-pin which renders this accident almost impossible. Detection of these foreign bodies is nearly always confirmed by a plain X-ray examination of the chest and the treatment is to remove them by operation.

(4) *Secondary Infection.*—Tuberculous or actinomycotic infections

occasionally complicate a septic empyema. Probably in such cases these organisms were present from the start, but were swamped during the acute phase of the empyema by pyogenic organisms of the streptococcus group, to reappear later as a cause of persistent sinus when the septic infection has been overcome by drainage. This complication may be recognised by the blue undermined edge of the sinus and the thin serous discharge of *tuberculous infection*; and by the nature of the discharge, possibly containing sulphur granules, and the multiplicity of the sinuses in the case of *actinomycosis*. Bacteriological investigation of the discharge will probably confirm the diagnosis. The treatment of these two rare complications is beyond the scope of this book.

(5) *Osteitis of the rib* may occasionally delay closure of the sinus, but this is exceptionally of such a degree as to cause anxiety. Should a sequestrum form, it must be removed.

Finally, there is a complication which, while it does not lead to delay in healing of the sinus, may give rise to some anxiety and that is *phlegmonous infection of the chest wall.* If this occurs the stitches around the tube must be taken out and open drainage instituted. This complication argues in fact that the tube was not water-tight in the empyema cavity, but that leakage was occurring round the tube and was unable to escape on to the surface. Kaolin or Antiphlogistine poultices are applied to the part.

III. THE HEART AND BLOOD-VESSELS

Coronary Thrombosis

Just as thrombotic complications are met with elsewhere after operation in a predisposed patient, so coronary thrombosis may constitute a post-operative complication. This accident may happen at any time in the post-operative period, particularly about the tenth to fourteenth days, and especially in middle-aged patients. While he is at rest or in his sleep, sometimes after a premonitory call to stool, the patient collapses and evinces all the classical symptoms of shock: the pulse is rapid and thready; the systolic and to a less extent the diastolic pressures fall; the patient is dyspnœic and ashen grey or cyanotic in colour; beads of perspiration stand out on the forehead and he casts about the bed or plucks at the bed-clothes in his restless anxiety Pain is variable; it may be little more than an epigastric or precordial discomfort, swamped by the magnitude of the mental and respiratory distress, or it may be so intense as to simulate an anginal attack or pulmonary embolism.

Angina pectoris is a rare post-operative complication. It is dis-

tinguished from coronary thrombosis because angina occurs during activity and therefore in the convalescent stage; the patient is pale and lies "frozen stiff", afraid to move, and the blood-pressure is raised. Moreover the pain of angina, although of great intensity, is of short duration, never lasting for more than a few minutes, whereas the pain of coronary thrombosis, if present, will persist until it is relieved by drugs. In both conditions physical signs relative to the heart may be absent, but in coronary thrombosis "tic-tac" rhythm, cardiac enlargement or irregularities of the beat may indicate a diseased myocardium.

Pulmonary embolism is dealt with below, but it may be distinguished from coronary thrombosis because the sudden intense pain dwarfs the other symptoms. This pain may occur anywhere over the chest, especially on the right side. It is never in the epigastrium and rarely in the precordial area, and it is exacerbated by each respiratory excursion. Later a pleural rub and the expectoration of blood-stained sputum will confirm the diagnosis. In coronary thrombosis, on the other hand, the later signs will be a pericardial rub and typical electro-cardiographic changes.

It is of the first importance to make a differentiation between these three post-operative catastrophes because the treatment is different in each case. In coronary thrombosis the patient should be left severely alone, examination being restricted to that necessary to establish a diagnosis. Hot bottles and warmed blankets are used to overcome "shock"; the patient is given a quarter of a grain of morphia, which may be repeated as often as is necessary, and he is reassured. Stimulants such as coramine are generally harmful and amyl nitrite is absolutely contra-indicated as it tends to lower an already depressed blood-pressure, thereby aggravating shock and rendering a spread of the thrombosis more likely. In angina pectoris, on the other hand, the blood-pressure is raised and the intense spasm can only be relieved by inhalations from a broken capsule of amyl nitrite. In all three cases the patient is rested in bed, in the instance of coronary thrombosis for a very long period. The subsequent treatment is a problem which is not our immediate concern.

Pulmonary Embolism

Post-operative Thrombosis and its Relation to Embolism

The clinical picture of pulmonary embolism makes it desirable to discuss this complication here That it is strictly a "vascular" and not a "chest" complication must be admitted; further, this arrange-

ment necessitates the inclusion of a section on post-operative thrombosis with which pulmonary embolism is inseparably linked.

Following an operation there are various changes in the constituents of the blood, such as an increase in the number of platelets, which render it more liable to spontaneous coagulation. Furthermore the venous circulation is slowed, an effect produced by the diminished respiratory excursions consequent on a painful abdominal wound and by recumbency. This slowly moving blood with a high coagulating potential is especially liable to clot where the venous stream is naturally at its most sluggish, as in the wide-bore vessels of the pelvis and legs, particularly after an operation where the abdomen has been opened. If a large vein of the leg such as the femoral or saphenous, or of the pelvis such as the external iliac, is occluded by a thrombus in this way no symptoms follow unless either (*a*) the clot becomes detached and is carried to the pulmonary arterial system where it becomes lodged in the pulmonary tree as an embolism, or (*b*) it becomes infected and causes a thrombophlebitis. Rarely both these complications occur together, and part of the clot which becomes infected remains in the vein to give rise to a thrombophlebitis and a part, usually a small part which is separated by necrotic softening, is carried to the pulmonary system as a small embolism or infarct. Commonly, however, where there is thrombophlebitis the infective process is sufficient to anchor the clot to the vein wall and prevent its dislodgment. That is why thrombophlebitis is so rarely followed by embolism or infarction and why embolism "appears out of the blue" following a symptomless, uninfected thrombosis.

Certain operations have a bad reputation in this respect, but thrombotic complications are relatively common after any operation demanding an abdominal wound in middle-aged or elderly patients. Many drugs, such as thyroid and heparin, have been used prophylactically and hardly a year passes without the publication of some fresh specific for these complications. The best prophylaxis consists in getting the patient into as fit a condition as possible pre-operatively, seeing that abdominal dressings restrict respiratory excursions as little as possible and encouraging early movement in bed.

Embolism and Infarct

The clinical picture of this condition varies with the size of the clot detached. Usually the convalescence from the operation is not absolutely smooth and there is often a slight nocturnal temperature. As was explained above, the pulmonary catastrophe is not often preceded by any evidence of venous thrombosis elsewhere, although a

thrombophlebitis of one or other leg, usually the left, may be met with, particularly before the smaller infected infarcts.

Embolism and infarction usually occur on about the tenth post-operative day, perhaps because at this time the patient is becoming more active and preformed clots are therefore liable to be disturbed. Sometimes, as in the case of secondary hæmorrhage, the catastrophe itself is ushered in by a desire to go to stool. The patient suddenly experiences an agonising pain in the chest, there is collapse, dyspnœa, cyanosis, a rapid thready pulse and diminished movement of the chest on one or other side. The blood-pressure is depressed and the patient shows all signs of suffering from severe shock. He may die at once, he may survive for a few minutes and then succumb, or he may slowly recover. If recovery ensues there will, in twenty-four hours, be a rise in the temperature and leucocyte count, and if the infarct involves the periphery of the lung there will be a pleuritic pain and a rub can be heard on auscultation. Later the rub will be softened by the pouring out of fluid and there may be a blood-stained expectoration.

Treatment

For those who are obviously recovering the treatment is expectant and symptomatic. *Morphia* is given in full doses to relieve pain and shock, and the vapour from a broken capsule of *amyl nitrite* is inhaled. *Coramine* may be required to stimulate a flagging circulation and *oxygen* should be given for the cyanosis. The patient's apprehensions should be allayed, and indeed justifiably, since a recurrence of this accident is unusual, and if the patient survives the first shock of impact he is likely to recover.

For those cases who survive for a short while but would eventually die there has been devised the most daring and ingenious operation originally described by Trendelenburg, by whose name it is known. This operation consists in opening the pulmonary artery and withdrawing the clot. At the time of writing a round dozen patients all the world over have survived this surgical *tour de force* and it may be assumed that at least some of these would have died had the operation not been performed. My own view, heterodox though it may be, is very strongly that this operation is never justified. It is not possible here to recapitulate the arguments for and against this operation, as these have already been dealt with fully elsewhere; I need only mention that there are two arguments which to my mind are conclusive. In the first place it is, I believe, impossible to tell at the time whether a patient who survives the immediate shock of an embolus is going to live or die. I have seen a patient apparently on the point of dis-

solution from pulmonary embolus who nevertheless recovered, and others have had the same experience. Had this patient been subjected to Trendelenburg's operation, then she might conceivably have become one of that select company of survivors and her name would be emblazoned in the surgical journals, although more probably she would have joined the majority whose names are perpetuated only on their tombstones. Secondly, it has been shown experimentally, and it is likely on clinical grounds, that most patients who die after pulmonary embolism die from shock, and the treatment for shock is rest, warmth and morphia.

THROMBOPHLEBITIS

This condition occurs mainly in the large veins of the left leg. This is probably due to the fact that the circulation, sluggish as it is in these veins, is retarded particularly in those of the left side, because the left common iliac vein into which they drain is crossed and pressed upon by the iliac and pelvic colon. The symptoms may come on at any time after an operation, especially in elderly subjects, and again after the abdominal cavity has been opened. There is first pain and tenderness along the course of the affected vein. Later the leg swells with œdema and the temperature, pulse-rate and leucocyte count rise.

Infarction only rarely complicates this state and, if it does so, is likely to be relatively mild. There is, however, more risk of infarction occurring in these patients than in patients without symptoms referable to these veins, and in order to prevent this and to control the spread of the infection the limb must be rested, elevated upon a pillow, until the acute symptoms have subsided, which usually occurs in about six weeks. The œdema is likely to persist in a mild form for longer and may be so troublesome as to demand prolonged rest with the limb in the elevated position. If the skin will tolerate it, an Elastoplast or Unna's paste bandage may help to disperse the œdema when the patient first gets on to his feet. Sedatives may be required for the pain and to induce sleep (p. 4) Thrombophlebitis may be looked upon as a troublesome complication of an operation which delays convalescence but which is rarely serious.

CHAPTER VI

THE ABDOMEN (PART ONE)

I. GENERAL CONSIDERATIONS

Distension

ALTHOUGH abdominal distension is more common after operations on the abdominal cavity, it is liable to occur after any operation as a result of immobilisation in bed, particularly after the application of a plaster spica or jacket. The patient will complain of discomfort and on examination the abdomen will appear distended both around the navel and in the flanks. Percussion gives a tympanitic note and auscultation usually reveals peristaltic sounds often of the high tinkling variety associated with small gut movements. The best prophylactic measure for such a state is to give the patient *solids* by the mouth as soon after the operation as possible. Exceptions to this rule must be made after certain operations on the stomach and intestines, which are dealt with specifically below. Unless vomiting precludes it, bread and butter, custards and thickened milky foods may be given on the day following the operation. On the second post-operative day boiled fish or creamed chicken with toast are often taken with relish. Nothing tends to gaseous distension of the gut so much as a prolonged course of " surgical fluids ". Even although the operation has been within the abdominal cavity, if it is of a relatively minor nature, such as the removal of an " interval " appendix or an early acutely inflamed appendix, then solid food may be given on the day following the operation. When the condition has become established a *rectal flatus tube* should be passed and *hot fomentations* over the whole abdomen often bring relief. These fomentations should be very well wrung out, otherwise they rapidly become cold and clammy and are a source of great discomfort. If there is an abdominal wound, then of course the fomentations must skirt this area so as to avoid damping the healing skin edge. *Charcoal biscuits* act by adsorbing the gases and, after the third day, unless there is peritonitis and rest of the bowel is demanded, 1 c.cm. of *Pituitrin* or eserine given subcutaneously and followed in twenty minutes by a *turpentine enema* produces a copious discharge of gas per rectum (Appendix I).

Two complications of abdominal distension are to be feared:

paralytic ileus and, if there is an abdominal wound, burst abdomen. The first of these complications is dealt with fully below in the discussion on peritonitis with which it is usually associated; the second must now be considered.

Burst Abdomen

Where, as after operations for acute intestinal obstruction, extreme tension on the abdominal wound is anticipated, an array of deep tension-sutures will have been introduced in order to prevent rupture of the wound. This measure, however, is not always successful. In the first place the tension may be so extreme that the sutures break or, as more commonly happens, the wound gives way between the sutures and knuckles of gut protrude. This complication is discovered when the wound is dressed. Generally the patient is aware that "the stitches have given way" and the accident often follows a bout of coughing. As soon as this state of affairs has been revealed the protruded bowel should be covered by gauze sponges wrung out in warm saline and the abdomen bound tightly to prevent further gaping. Preparations are then made to take the patient to the theatre where, under a full general anæsthetic, the wound is re-sutured. What can be done at the operation depends upon a variety of circumstances. Ideally the wound should once more be stitched up in layers, using strong catgut and interrupted sutures for the peritoneum and fascia, deep tension-sutures and interrupted silkworm-gut for the skin. As may be imagined, however, the operation is often one of considerable difficulty, particularly if the anæsthetic is shallow, and as soon as the wound is explored, fresh coils of intestine prolapse with considerable force and there may indeed be danger of complete evisceration. In order to overcome these difficulties a "*rubber fish*" is often of great help. This consists of an oblong sheet of rubber eight inches by three inches and an eighth of an inch thick, to one end of which is attached a tape. It is often possible to insert this rubber sheet over the prolapsed coils of intestine but under the edges of the peritoneum and to stitch up the wound with this shield in place. When about two inches remain to be sutured the rubber sheet is withdrawn by means of the attached tape. As far as possible the wound should be sutured in layers, but this is often impracticable, and it may be necessary to take large bites of tissue passing through all layers from skin to peritoneum. If this is so, silkworm-gut should be used. When by this means the wound is somehow or other brought together, with the aid perhaps of an assistant exerting pressure from the sides, the skin is sutured with closely placed interrupted stitches of silkworm-gut and corsettage used to relieve the

tension. Elaborate methods of *corsettage* have been described, but a simple method and one readily available is to thread tapes into the ends of pieces of adhesive strapping about six inches long. The adhesive strapping is then applied on either side of the wound and the tapes are tied tightly over the ordinary dressings. In these circumstances an exception to the rule may be made and on top of this a "many-tail" bandage should be applied.

Opening the Bowels

This same "laziness" of the intestine after operation which leads to distension may give rise to difficulty in opening the bowels. Each surgeon usually has very strong views as to when the bowels should be opened after an abdominal operation, and it is a pity that these views do not all coincide. Certainly the passage of a stool gives great relief to the patient, not untinged by psychological satisfaction, and this has influenced some surgeons to advise a drastic purge as early as the third day. Other surgeons are so impressed with the necessity for resting the distended gut that they forbear all interference until the fifth post-operative day. This problem will be gone into in greater detail in discussing paralytic ileus, but a satisfactory compromise is to administer a mild vegetable purge such as senna or cascara on the evening of the third post-operative day, followed by a soap enema on the morning of the fourth (p. 15).

Post-operative Adhesions

Sometimes after the peritoneum has been opened a patient will complain of abdominal pain for which there is apparently no satisfactory explanation. This pain generally arises during convalescence and never completely disappears, although it may periodically abate. It is usually complained of beneath the site of the abdominal scar, which is sometimes keloid, and it may be aggravated by dietary indiscretions or by exercise. The severity of the pain may be increased by taking food or by failing to pass a regular bowel motion. Occasionally it is accompanied by audible or visible peristalsis. Such a syndrome is due to "adhesions" In those cases showing physical signs—keloid scar or increased peristalsis—there is usually a physical lesion to account for the symptoms, but in nearly all cases there is, in addition, a pronounced psychological element. It is this psychological element which renders operation so rarely effective even if, as is not always the case, some abnormality is found at laparotomy which can be put right. Many of these cases have been submitted to a number of

operations and their abdominal wall is a criss-cross of scars. A common history is "1924, Gastro-jejunostomy; 1927, Cholecystectomy; 1929, Gastro-jejunostomy undone; 1932, Appendicectomy and division of adhesions." As my colleague Mr. Slesinger is wont to remark in such cases, "the adhesions are less in the abdomen of the patient than in the mind of the surgeon who can be prevailed upon to operate."

To open the peritoneum again in these circumstances serves but to add fresh adhesions to those already there, and only if the symptoms of subacute or acute intestinal obstruction are present should operation be undertaken. Abdominal adhesions are, however, very difficult to treat. The patient may indeed be in danger of becoming obstructed and yet undue precautions in this regard tend to focus his attention on his complaint and render him all the more anxious about a complication which may never occur. The conduct of such a case is, therefore, a therapeutic problem of some nicety.

In regard to physical treatment such a patient should be careful of his diet. Large bulky meals of indigestible matter must be avoided, but light meals should be taken at frequent intervals. Liquid paraffin is prescribed in suitable doses, which the patient will determine for himself. Exercises such as bending the trunk forwards, backwards and sideways, which tend to stretch the adhesions, may be practised and always plenty of fresh air and walking should be indulged in. Abdominal massage is of great benefit to some patients, but others find that it stirs up the pain, and, if it is ordered, the effect must be carefully watched.

The psychological side must be tackled with discernment and each patient requires a different method of approach. He must be encouraged to take an interest in outside affairs and warned against introspection. My experience is that an attitude of frankness is usually repaid in these cases and so the following plan is that which is generally adopted. It is explained to the patient that he has got some scar tissue inside the abdomen as a result of his previous operation which, with the normal bowel movements, is apt to be dragged upon and give rise to pain; that to operate and cut these adhesions is only to replace them by others. It is pointed out that in course of time the pain will gradually get less but that there are two dangers: one is a very small danger, comparable to that taken if the patient elected to fly in an aeroplane for a week-end trip to the sea-side, and this is that the symptoms might suddenly become acute and demand an operation. This danger is really sufficiently slight for the patient to be able to disregard it at the expense of altering his whole attitude to life. The second danger is a very big one which the patient must himself fight

strenuously against, and this is that he may dwell upon his symptoms, exaggerating discomfort into pain and pain into agony so that he becomes, for the rest of his life, a misery to himself and those who have the misfortune to live with him. The patient is reminded that many people have a slight disability which they carry with them through their lives, one has an arthritic knee, another a weak chest; that he also has a slight disability and that it depends upon his stoicism and courage whether this is going to upset the whole tenor of his ways, or if it is going to be regarded in its proper proportion and allowed to interfere as little as possible with the natural cheerfulness of life.

II. PERITONITIS

Over the treatment of peritonitis there has perhaps been greater difference of opinion than over any other common surgical complaint. Peritonitis is usually secondary to some infective focus such as appendicitis, cholecystitis and salpingitis, or it follows the perforation of some part of the gastro-intestinal tract. Rarely the infection of the peritoneum is a primary one from the blood-stream and occurs during the course of pneumonia or other septicæmia. The more chronic forms of tuberculous peritonitis do not constitute problems of " After-treatment " and will not therefore be considered here. Owing to the infection of the peritoneum the intrinsic nerves of the gut wall become paralysed and peritonitis therefore naturally leads to *paralytic ileus.* It is over the treatment of paralytic ileus that such divergent views have been held.

Clinical Aspect

Post-operative peritonitis can present a difficult problem in diagnosis. Many of the common signs of peritonitis, such as pain, pyrexia and rigidity, may be absent and the whole picture tends to be coloured by the paralytic rather than the infective aspects. The diagnosis may be made at the operation from the state of the peritoneum at that time, *but frequently the peritonitis arises after the operation, and it is* then that the diagnosis may be in doubt. Apart from the fact that post-operative peritonitis is especially liable to develop paralytic ileus, paralytic ileus may occur without any peritoneal infection preceding it; indeed, rarely it may complicate operations where the peritoneum has not been opened, and it is thought by some to be due to a stimulation of the sympathetic system. Operations upon the kidney, spine and chest are followed occasionally by paralytic ileus and in these operations the possibility of sympathetic stimulation is manifest.

As far as treatment is concerned, there is no need to differentiate between peritonitis and paralytic ileus, the one following the other like a shadow; and, in the description that follows, it must be assumed that where the term "peritonitis" is used it necessarily includes its Siamese twin "paralytic ileus", although one twin may be sometimes of greater and sometimes of less importance than its counterpart.

The signs of post-operative peritonitis are elevation of the pulse-rate, abdominal distension with diminished peristalsis and later "ballooning" of the rectum. The patient feels ill and anxious and there is persistent vomiting. The vomit is at first of gastric contents, but later becomes dark and foul-smelling and may be brought up in large quantities without effort, so that an almost continual regurgitation stains the lips and chin. As a result of vomiting and the out-pouring of fluid into dilated coils of intestine the patient becomes acutely dehydrated. The tongue, apart from moisture of the vomit, is essentially dry and stained with bile. The teeth lose their sheen and stick to the parched lips. The eyes are sunken and the cheeks hollow, giving the well-known "Hippocratic facies" which is the herald of death. The pulse-rate becomes further quickened and the diminished blood- and pulse-pressure render it eventually almost imperceptible. Cyanosis appears and the nose and forehead are cold to the touch. Often up to the end the patient is fully conscious and tragically aware of his desperate condition.

Treatment

We must assume that if there is a primary focus of the peritonitis it has been dealt with according to accepted principles and that we are left to undertake the subsequent treatment. The patient should be placed in the *Fowler position*. This allows such peritoneal exudate as does not escape via the drainage tubes to collect in the pelvis. The pelvic peritoneum is equally as absorptive as the peritoneum elsewhere, so that this measure does not diminish the absorption of toxic products, but it ensures that should a residual abscess form it will tend to do so in the pelvis where it can do relatively little harm, often discharging spontaneously by the rectum or the vagina. By this means the danger of the more serious subphrenic abscess is minimised.

Fluids must be given freely. This problem has been discussed above (p. 10), and it was there explained that the fluid requirements of an adult patient suffering from peritonitis (allowing for vomiting, gastric suction, fluid escaping by drainage tubes and fluid stagnating

strenuously against, and this is that he may dwell upon his symptoms, exaggerating discomfort into pain and pain into agony so that he becomes, for the rest of his life, a misery to himself and those who have the misfortune to live with him. The patient is reminded that many people have a slight disability which they carry with them through their lives, one has an arthritic knee, another a weak chest ; that he also has a slight disability and that it depends upon his stoicism and courage whether this is going to upset the whole tenor of his ways, or if it is going to be regarded in its proper proportion and allowed to interfere as little as possible with the natural cheerfulness of life.

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may be given intramuscularly at the time of operation, and 4,000 units on each of the two or three subsequent days depending upon the degree of toxæmia.

With regard to *paralytic ileus* there are two schools of thought. The one claim that the lazy bowel must be stimulated into activity by giving injections of Pituitrin or eserine followed by enemata. The other insist that the irritated bowel should be rested and given a chance to recover. The latter school also point out that localisation of infection within the peritoneal cavity is more likely to occur if intraperitoneal movements are stilled. It is no purpose of this book to plunge into a controversy to which there is at present no answer, and the dictates of the surgeon in this regard must be followed by whoever takes care of his case. It may, however, be mentioned that nowadays an overwhelming majority of experienced surgeons advocate rest to the bowel until recovery is well advanced.

Morphia is a most valuable drug in peritonitis. It eases the pain and so alleviates shock, and it promotes rest. The "*active*" school aver that much of its benefit accrues from the fact that it stimulates bowel activity, a property which can be demonstrated by suspending excised portions of bowel in Ringer's solution to which morphia is added. The "*passive*" school reply that morphia paralyses the bowel, as is evidenced by the constipating effect of the tincture of opium given by the mouth; and the pharmacologist, sheltering behind the phenomenon of tautomerism, asserts that in certain doses it stimulates and in others it paralyses the bowel.

In cases of extreme paralytic ileus the operation of *ileostomy* is sometimes considered. This operation consists in making a small incision into the abdomen under a local anæsthetic and inserting a rubber tube into the first coil of ileum which prolapses. Many patients apparently *in extremis* have recovered following this decompression of the bowel, but the opponents of the operation say that they would have recovered in any case and cite certain theoretical objections to the operation. The problem is unanswerable, the situation being similar to that of the Trendelenburg operation for pulmonary embolus (p. 106); but here at least the exponents of ileostomy can claim that the operation is not one of great magnitude and can be performed in bed.

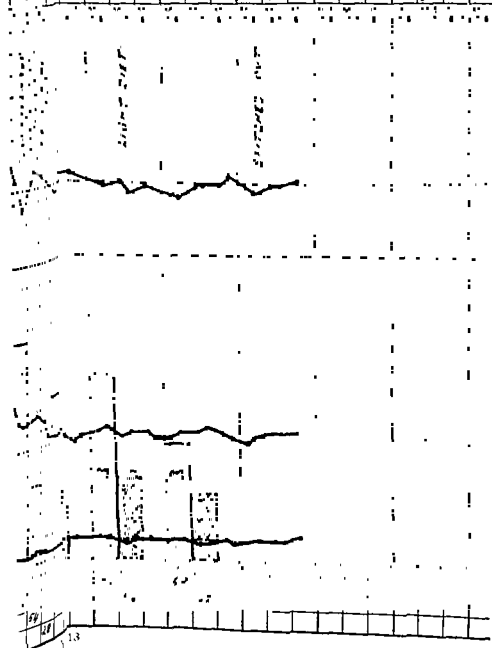
The theoretical objections are that a very ill patient is being subjected to the strain of a further operation, however slight this may be; that the coils of gut are so distended that the gut between the coils is kinked and this prevents communication taking place between one coil and another, so that all that the operation succeeds in doing is to drain the coil which is opened; and lastly, that for some reason the ileostomy never starts to work satisfactorily for twenty-four hours, by which time

in distended coils of gut) were in the region of 8 pints in the twenty-four hours. For reasons outlined above four of these pints should consist of 5 per cent. glucose solution in distilled water and four of normal saline. In these cases the intravenous route is incomparably the best, as nothing should be given by the mouth, so as to rest the gut. Further it is unlikely that the rectum will tolerate the large quantities of fluid required ; and, moreover, rectal glucose may ferment and increase the gaseous distension of the lower bowel. The subcutaneous route is likewise unsuitable when large quantities of fluid are necessary. For children the volume of fluid delivered in the twenty-four hours must be reduced proportionately and the greatest care must be taken to see that pulmonary œdema, to which children are peculiarly liable, does not follow the intravenous administration of fluid. For a child of five with peritonitis, 2–2½ pints of fluid (in the twenty-four hours) are all that is required and for a child of ten, 3–4 pints.

If *vomiting* occurs which cannot be accounted for by the anæsthetic and always if vomiting takes place after twelve hours from giving the anæsthetic, a gastric suction apparatus is set up (p. 12). This procedure *is undertaken as a routine where peritonitis is established,* whether the patient has vomited or not. If the abdomen becomes distended, a *flatus tube* should be passed by the rectum. To combat toxæmia, injection of a soluble sulphonamide through the intravenous tube may be considered. New sulphonamides, and soluble forms of old ones, appear so rapidly on the market that it is not possible to be more explicit. The recognised properties of well-known sulphonamides are shown in tabular form on page 30. The *pulse-rate* is *recorded each hour* and the *volume of urine* secreted is measured. These two records are valuable indications of prognosis. If chlorides disappear from the urine as evidenced by the silver nitrate test (p. 11), the proportion of chloride in the intravenous infusion must be increased and the glucose reduced (Fig. 13).

So far there can be little disagreement with the course of treatment outlined.[1] The first problem about which there has been considerable discussion is the use of *anti-gas-gangrene serum.* It is not proposed to enter into the details of the experimental and somewhat scanty clinical evidence as to the value of this measure. It is certain that much of the toxæmia in these cases is due to the gas-forming anaerobes which acquire a high degree of pathogenicity in the stagnating coils of intestine, and it is generally admitted that the exhibition of anti-gas-gangrene serum in anaerobic infections of wounds is of some value, at least prophylactically. On these grounds 12,000 units of the serum

[1] Written before May, 1946, when the Fowler position came in for destructive criticism (*Lancet*, 1946, 1, 643). A final assessment of the value of the Fowler position must await further observation.


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NAVAL FORM. M 41
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MONTH | *JUNE*

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.. OF | *1* | *2* | *3*

TEMPERATURE F°: 106, 105, 104, 103, 102, 101, 100, 99, 98, 97, 96, 95

OPERATION

PULSE: 150, 140, 130, 120, 110, 100, 90

RESPIRATION: 80, 70, 60, 50, 40, 30, 20

B.O.

120 *18* *80* *124* *42* *48* *124* *54* *28* *94*

Fig

the future. In general, however, I have found it eminently satisfactory in dealing with the commonest type of case where the operation for the primary cause of the peritonitis is undertaken within twenty-four hours of the appearance of this complication. It has proved especially valuable in cases of appendicitis and perforated ulcer complicated by peritonitis. " Zero hour " is taken as the time of the operation and the treatment is then outlined for each of the three twenty-four-hour periods following this. The scheme is capable of modification according to the progress of the case, and the possible permutations and combinations are so many that it would be impracticable to outline a scheme which would cover every contingency.

First Twenty-four Hours

(*a*) Fowler position.

(*b*) Intravenous drip infusion to deliver 8 pints in the twenty-four hours, 4 pints being of 5 per cent. glucose in distilled water and 4 of normal saline.

(*c*) Morphia gr. $\frac{1}{6}$ four-hourly.

(*d*) Gastric suction.

(*e*) Twelve thousand units of anti-gas-gangrene serum.

(*f*) A course of a soluble sulphonamide by the intravenous tube if the patient is severely toxic.

Second Twenty-four Hours

(*a*) Fowler position.

(*b*) If peristaltic sounds become audible with the stethoscope, the gastric suction is clamped off and sips of water starting with $\frac{1}{2}$ ounce an hour and working up to 4 ounces an hour within eight hours may be given. As soon as 4 ounces an hour can be taken without vomiting, the " intravenous drip " can be taken down and the gastric tube withdrawn. If the fluid by the mouth induces vomiting, keep up the drip and the gastric suction for a further six hours, then try again.

(*c*) Continue morphia until peristaltic sounds become audible.

(*d*) Four thousand units of anti-gas-gangrene serum.

(*e*) Continue course of sulphonamides if indicated.

(*f*) At the end of this period drainage tubes must be shifted. If there is no discharge they can be withdrawn slightly. They must be shifted or withdrawn (depending on the discharge) every twenty-four hours subsequently.

the need for it has passed. These arguments can all be countered by operating in time and the whole crux of the question hinges upon this—when is the correct time? Certainly if ileostomy is carried out "in time", many unnecessary ileostomies will be performed, and the solution to this difficult problem must be left to the judgment and inclinations of the surgeon in charge of the case.

I have called this type of operation "*post-operative ileostomy*", and in passing I should like to enter a plea for what I have termed "*syn-operative ileostomy*", that is, an ileostomy performed at the same time as the original operation for dealing with the primary focus. None of the theoretical objections to post-operative ileostomy applies to syn-operative ileostomy, and I take the indication for this latter operation to be a distended, paralytic appearance of the intestine at the time of the first operation.

The introduction of the *Miller Abbot tube* or a modification of such a tube may in future render the operation of ileostomy obsolete. This tube, which is many feet in length, and of about the same calibre as a Ryle's tube, is swallowed. A distensible bulb at the end of the tube is engaged by the pylorus and the tube steadily passes down the intestine, being paid out into the mouth. As it progresses down the intestinal tract the contents of succeeding loops of bowel are aspirated and the bowel is therefore decompressed from above. In practice it is found to be very satisfactory if the tube can be induced to pass through the pylorus with the patient lying on his right side, but with the patterns at present on the market this often fails and the tube coils up inside the stomach. The Miller Abbot tube is designed to be withdrawn through the mouth, however far it has been passed. A tube, the end of which reaches as far as the ileo-cæcal valve, can be removed in fifteen minutes. Einhorn states, however, that if the whole tube is allowed to pass into the gastro-intestinal tract, it will invariably present at the anus, in which case it can be voided through that aperture

A spinal anæsthetic sometimes relieves a paralytic ileus, but the measure is fraught with danger, as the lowering of the blood-pressure in an already severely shocked patient may prove fatal. The intravenous injection of hypertonic saline has similarly proved highly dangerous.

How then are we to deal in practice with this extremely common disorder? Below is a table which I made out some years ago, a copy of which I leave at the nursing home or hospital where my cases of peritonitis are being treated. In the course of the last ten years it has changed in some of its details and doubtless will be modified in

certain operations for appendicectomy and for the closure of gastric and duodenal perforations. When abscesses form in this way they are thought generally to originate in pools of septic peritoneal exudate which are not freely drained. The location of these pools is determined by the peritoneal watersheds (Fig. 14), and they tend therefore to appear in well-recognised situations. The presence of a residual abscess may be suspected when, after an operation for a septic condition within the peritoneal cavity, the temperature fails to settle and later tends to swing ; the patient appears toxic, and has a rapid pulse and a furred tongue.

There are three common sites where these abscesses may be located. They may appear deep to the abdominal wound arising in the

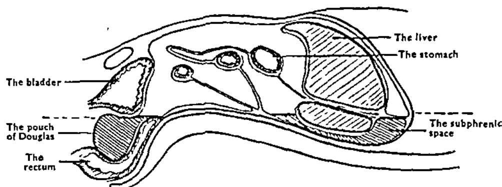


FIG 14 —The peritoneal watersheds in the supine position, showing the importance of the Fowler position in preventing subphrenic abscess

situation of the primary focus of infection, such as the right iliac fossa following appendicectomy ; in the pelvis ; or under the diaphragm.

In the first area the abscess rapidly becomes apparent. The region around the wound becomes red, swollen, œdematous and tender. A tender lump may be felt deep to the abdominal wall and a purulent discharge may appear on the surface. Unless the patient's general condition deteriorates or the abscess grows in size or signs of peritonitis develop, the treatment of this condition is at first conservative. As it is exceptionally rare for an infection within the peritoneal cavity, which has succeeded in localising itself in the first place, to burst and give rise to a general peritonitis, there is no occasion for hurry to drain the collection. On the other hand, the rough handling of a tender abdominal lump in order to elicit precisely the physical signs is not without danger. Conservatism is indicated also on the grounds that the abscess may resolve spontaneously, but more particularly because if it is opened before it becomes firmly adherent to the abdominal wall it may

Third Twenty-four Hours

(*a*) Fowler position.

(*b*) If the attempt to take 4 ounces of fluid in an hour without vomiting was successful during the preceding period, solids in the form of bread and butter or minced fish may be given. If these attempts were not at first successful, solid food should be withheld until twenty-four hours after an attempt to take at least 4 ounces of fluid by the mouth without vomiting has proved successful. This procedure can be followed whether or not the bowels have acted.

(*c*) Morphia is withheld or given according to whether peristaltic sounds are present or absent.

(*d*) Four thousand units of anti-gas-gangrene serum, if necessary.

(*e*) Continue course of sulphonamide, if indicated, through the intravenous tube which will have been retained.

(*f*) At the end of this period, that is seventy-two hours from the time of the operation, and if peristaltic sounds are audible, a turpentine enema (Appendix I) is given. Should this be unsuccessful, 1 c.cm. of eserine is given four hours later, followed in twenty minutes by another turpentine enema. Stimulation of the bowel in this way waits in any case on the presence of peristaltic sounds.

Where, as after an operation for early acute appendicitis or a very early perforated ulcer, peritonitis is not anticipated, the above scheme may be modified. The Fowler position must be maintained and the principles in regard to morphia administration are satisfactory. Unless there is much distension, an enema will usually be successful after seventy-two hours without the aid of Pituitrin, and there is no need for anti-gas-gangrene serum or sulphonamide unless signs of toxæmia appear. As vomiting will probably stop as soon as the effects of the anæsthetic have worn off, the short interval before fluid can be taken in adequate quantities by the mouth may be bridged by giving a rectal infusion. Should, however, the signs of peritonitis or paralytic ileus develop, it would be well to adopt the scheme outlined above with all its rigours, including intravenous infusion and gastric suction.

III. RESIDUAL ABSCESS

Peritonitis may resolve completely or foci of infection may be walled off and form residual abscesses. The latter is less likely to occur after a diffuse general peritonitis than when the infection has remained confined to the area of the primary focus, and it is particularly common following appendicitis and after appendicectomy. It is to prevent this complication that drainage tubes are inserted into the peritoneal cavity after

certain operations for appendicectomy and for the closure of gastric and duodenal perforations. When abscesses form in this way they are thought generally to originate in pools of septic peritoneal exudate which are not freely drained. The location of these pools is determined by the peritoneal watersheds (Fig. 14), and they tend therefore to appear in well-recognised situations. The presence of a residual abscess may be suspected when, after an operation for a septic condition within the peritoneal cavity, the temperature fails to settle and later tends to swing; the patient appears toxic, and has a rapid pulse and a furred tongue.

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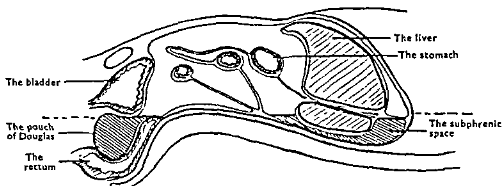


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be necessary to traverse clean peritoneum in approaching the abscess surgically and this will probably lead to a spread of the infection. A course of sulphonamide is instituted, the patient placed in the Fowler position and a light diet prescribed, although there is no need to adhere strictly to fluids. Antiphlogistine should be applied over the area of the swelling and changed every four hours. The abscess will either subside or approach the surface. If the wound is not completely healed by this time it may readily discharge itself spontaneously ; but more usually, when the abscess has reached the subcutaneous tissue as is evidenced by increased œdema, heat, redness and fluctuation, an incision is required and a drain is inserted.

PELVIC ABSCESS

Pus may collect in the pouch of Douglas and form a pelvic abscess. The general signs of imprisoned pus will be present, and in addition there may be localising symptoms such as diarrhœa or frequency of micturition from irritation of the rectum or bladder. Rectal examination may reveal a tender mass in the pouch of Douglas and there may be œdema of the anterior rectal wall or even ballooning of the rectum. A swelling of the posterior fornix is felt on vaginal examination. The natural course of a pelvic abscess is either to resolve or to discharge itself spontaneously into the rectum, the vagina, or more rarely, the bladder. Occasionally it will rise up out of the pelvis and point on the anterior abdominal wall above Poupart's ligament. Again the keynote of treatment is conservatism Sulphonamides are prescribed, the Fowler position is adopted and hot wash-outs are given to the rectum or vagina. Fluids are given freely, but there is no need to withhold light solid food should the patient desire it. *Operations*, such as posterior colpotomy for drainage of the abscess through the posterior fornix of the vagina or incision of the anterior rectal wall, should be undertaken when the abscess is pointing at one of these sites and only by a surgeon familiar with the exact indications for these operations, otherwise serious damage may be sustained to a loop of ileum lying in the pouch of Douglas. After such an operation a tube half an inch in diameter is passed into the abscess cavity and emerges from the vagina or the rectum where it is stitched to the skin. Unlike drainage tubes elsewhere this tube should be left undisturbed for four days, when the stitch is removed and the tube shifted. Not being secured by a stitch the tube is very likely to come out of the abscess cavity during the course of the next forty-eight hours and if it does so it need not be replaced. It should be removed completely after six days if it has not come out before Hot vaginal wash-outs may be given each

day, but in a male it will not be possible to give rectal wash-outs, and these must therefore be dispensed with at least until the tube has come out when, as indicated by the absence of discharge and the settling of the temperature, they will probably no longer be necessary. Paraffin ℥ i is given night and morning after the first day. If the bowels have not acted, a mild aperient (cascara or senna) is given on the evening of the third day.

In late cases, if it is possible to do so without exercising undue force, it is permissible to *pass a finger* through the anterior wall of the rectum or through the posterior vaginal fornix into the abscess when the œdematous and friable condition of these tissues guarantees that the abscess immediately underlies them. Hot vaginal or rectal wash-outs are continued until the temperature abates and the discharge ceases. The bowels are opened as described above. Should the abscess present on the anterior abdominal wall, the same considerations apply as in the first type of abscess discussed.

Subphrenic Abscess

Lastly there is the most important subphrenic abscess. This abscess is generally suspected in the first place because the signs of imprisoned pus are present, but there is no evidence of a pelvic abscess or of an abscess at the site of the original inflammation. "*Pus somewhere; pus nowhere else; pus under the diaphragm.*" There is, in other words, a swinging temperature, a rapid pulse, a furred tongue and other evidence of toxæmia, but no localising signs. It is to be suspected particularly after operations for inflammatory conditions in the upper abdomen such as perforation of gastric or duodenal ulcer.

In these circumstances positive signs of subphrenic abscess are looked for and attention is paid to this possibility until the signs abate or the infection becomes manifest elsewhere. Various anatomical classifications of subphrenic abscess have been devised depending upon whether the collection is in relation to the peritoneal surface of the diaphragm, and whether it is in front of or behind the coronary ligaments of the liver. It is not proposed to discuss these types in detail, but it may be mentioned that the commonest site is up against the peritoneal surface of the diaphragm behind the coronary ligament on the right side. A reference to the diagram of peritoneal watersheds will show that this region is a natural pool for the collection of fluid arising from common foci of intraperitoneal infection.

There will be diminished movements of the chest on the side affected and the respiration-rate will be increased. There may be an area of tenderness and œdema alongside the twelfth rib. Percussion

be necessary to traverse clean peritoneum in approaching the abscess surgically and this will probably lead to a spread of the infection. A course of sulphonamide is instituted, the patient placed in the Fowler position and a light diet prescribed, although there is no need to adhere strictly to fluids. Antiphlogistine should be applied over the area of the swelling and changed every four hours. The abscess will either subside or approach the surface. If the wound is not completely healed by this time it may readily discharge itself spontaneously ; but more usually, when the abscess has reached the subcutaneous tissue as is evidenced by increased œdema, heat, redness and fluctuation, an incision is required and a drain is inserted.

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Pus may collect in the pouch of Douglas and form a pelvic abscess. The general signs of imprisoned pus will be present, and in addition there may be localising symptoms such as diarrhœa or frequency of micturition from irritation of the rectum or bladder. Rectal examination may reveal a tender mass in the pouch of Douglas and there may be œdema of the anterior rectal wall or even ballooning of the rectum. A swelling of the posterior fornix is felt on vaginal examination. The natural course of a pelvic abscess is either to resolve or to discharge itself spontaneously into the rectum, the vagina, or more rarely, the bladder. Occasionally it will rise up out of the pelvis and point on the anterior abdominal wall above Poupart's ligament. Again the key-note of treatment is conservatism. Sulphonamides are prescribed, the Fowler position is adopted and hot wash-outs are given to the rectum or vagina. Fluids are given freely, but there is no need to withhold light solid food should the patient desire it. *Operations*, such as posterior colpotomy for drainage of the abscess through the posterior fornix of the vagina or incision of the anterior rectal wall, should be undertaken when the abscess is pointing at one of these sites and only by a surgeon familiar with the exact indications for these operations, otherwise serious damage may be sustained to a loop of ileum lying in the pouch of Douglas. After such an operation a tube half an inch in diameter is passed into the abscess cavity and emerges from the vagina or the rectum where it is stitched to the skin. Unlike drainage tubes elsewhere this tube should be left undisturbed for four days, when the stitch is removed and the tube shifted Not being secured by a stitch the tube is very likely to come out of the abscess cavity during the course of the next forty-eight hours and if it does so it need not be replaced. It should be removed completely after six days if it has not come out before. Hot vaginal wash-outs may be given each

day, but in a male it will not be possible to give rectal wash-outs, and these must therefore be dispensed with at least until the tube has come out when, as indicated by the absence of discharge and the settling of the temperature, they will probably no longer be necessary. Paraffin ℥ i is given night and morning after the first day. If the bowels have not acted, a mild aperient (cascara or senna) is given on the evening of the third day.

In late cases, if it is possible to do so without exercising undue force, it is permissible to *pass a finger* through the anterior wall of the rectum or through the posterior vaginal fornix into the abscess when the œdematous and friable condition of these tissues guarantees that the abscess immediately underlies them. Hot vaginal or rectal wash-outs are continued until the temperature abates and the discharge ceases. The bowels are opened as described above. Should the abscess present on the anterior abdominal wall, the same considerations apply as in the first type of abscess discussed.

Subphrenic Abscess

Lastly there is the most important subphrenic abscess. This abscess is generally suspected in the first place because the signs of imprisoned pus are present, but there is no evidence of a pelvic abscess or of an abscess at the site of the original inflammation. "*Pus somewhere ; pus nowhere else ; pus under the diaphragm.*" There is, in other words, a swinging temperature, a rapid pulse, a furred tongue and other evidence of toxæmia, but no localising signs. It is to be suspected particularly after operations for inflammatory conditions in the upper abdomen such as perforation of gastric or duodenal ulcer.

In these circumstances positive signs of subphrenic abscess are looked for and attention is paid to this possibility until the signs abate or the infection becomes manifest elsewhere. Various anatomical classifications of subphrenic abscess have been devised depending upon whether the collection is in relation to the peritoneal surface of the diaphragm, and whether it is in front of or behind the coronary ligaments of the liver. It is not proposed to discuss these types in detail, but it may be mentioned that the commonest site is up against the peritoneal surface of the diaphragm behind the coronary ligament on the right side. A reference to the diagram of peritoneal watersheds will show that this region is a natural pool for the collection of fluid arising from common foci of intraperitoneal infection.

There will be diminished movements of the chest on the side affected and the respiration-rate will be increased. There may be an area of tenderness and œdema alongside the twelfth rib. Percussion

of the chest on the side of a fully developed abscess classically reveals four distinct layers from above downwards: a layer of resonance due to normal lung, a layer of dullness due to compressed lung, a layer of resonance from a large gas-bubble inside the abscess and a layer of dullness due to the abscess itself (Fig. 15). In practice I have found that the layer of resonance due to the gas-bubble is often unobtainable, and the layer of resonance of normal lung above gives way to a layer of

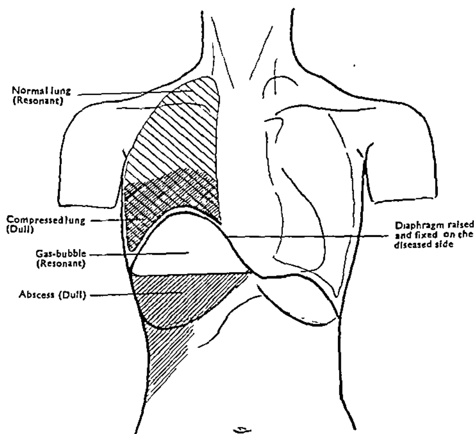


Fig 15 —Layers of alternating resonance and dullness in subphrenic abscess The layer of resonance due to the gas-bubble is not generally detectable and the resonance of normal lung above gives way to the dullness of compressed lung and abscess below.

dullness over the base of the chest which blends with the dullness of the abscess. The upper level of dullness does not tend to rise into the axilla as in collections of fluid within the pleural cavity, and this is a most important point in the differential diagnosis from empyema with which subphrenic abscess may be confused. The mediastinum is raised and shifted towards the opposite side, as is evidenced by displacement of the apex-beat. An X-ray photograph of the chest must be taken (Fig. 16) and this shows that the diaphragm is raised and



FIG. 16.—Subphrenic abscess.

immobile on the affected side and there may be a bubble of gas underneath it. Shifting of the mediastinum will be confirmed. An important sign in the X-ray photograph of an uncomplicated subphrenic abscess and one which again serves to distinguish it from empyema is that the costo-phrenic angle is clear.

Unlike other residual abscesses it is believed that a subphrenic abscess may not always originate in a pool of peritoneal exudate, particularly if the patient has been nursed in the Fowler position, but may result from suppuration in a subphrenic peritonitis or cellulitis due to lymphatic spread from a focus of infection lower down in the peritoneal cavity. The old teaching was that a subphrenic abscess should be evacuated without delay, but surgeons are coming round to the view that such collections should, like abscesses elsewhere, be left until localisation is well advanced and the surrounding cellulitis has subsided. It is not easy to say when is the correct time for the evacuation of such an abscess by rib-resection because the delayed evacuation of a subphrenic collection is only a relatively recent attempt to lessen the alarming mortality following the older methods of treatment, and the indications have not been fully worked out. Further, the advent of sulphonamides, which should always be prescribed in this condition, has altered the natural history of the disease and the time is not ripe for a final pronouncement on the proper treatment of this complication. It may be said, however, that there is not the desperate urgency about draining these abscesses that was previously thought to be the case and the type of subphrenic abscess which, after great difficulty, rewards the conscientious needler with a few c.cm. of pus should probably be left. At the other end of the scale the appearance of a gas-bubble or a well-raised cupola of the diaphragm as seen on X-ray examination demands that the abscess be evacuated.

The technique of drainage of a subphrenic abscess is a problem for the surgeon and may present many difficulties. It is, however, of the greatest importance that those who are responsible for the after-treatment of any operation case should be familiar not only with all possible complications but also with their differentiation.

The *differential diagnosis* of subphrenic abscess is *from empyema.* The clinical and radiological features outlined above should in most cases serve to establish the diagnosis as between these two conditions. Further, subphrenic abscess is to be expected after peritoneal infections, and empyema only after obvious chest infections. Rarely, however, the diagnosis is in doubt but it is most important that this differentiation should be clearly made because the technique of approach in these two conditions is different.

Confusion arises where a *subphrenic abscess* is *associated with a sympathetic effusion into the pleural cavity*, or where a subphrenic abscess bursts or spreads through the diaphragm and is *associated with an empyema*. In both these circumstances the area of dullness of the lower chest will rise into the axilla and radiologically the costo-phrenic

angle will be obliterated. If, after a peritoneal infection, the general symptoms and signs are those of imprisoned pus and the movements of the chest are restricted on one side with dullness rising up into the axilla and there is radiological obliteration of the costo-phrenic angle indicating fluid in the chest, the presence of a coincidental subphrenic abscess may still be betrayed by a gas-bubble in the midst of the dense area, well above the normal level of the cupola of the diaphragm. Unless there has been a chest infection it is extremely unlikely that the pleural fluid is other than a sympathetic effusion. Whether or not the diagnosis of subphrenic abscess as well as empyema can be made at this stage, the procedure, when there is rising dullness in the axilla and obliteration of the costo-phrenic angle, is to needle the chest just below the upper level of dullness. If clear fluid is withdrawn, it indicates a sympathetic effusion into the pleura following a subphrenic abscess and the latter must be drained. If pus is withdrawn, it indicates either an uncomplicated empyema or an empyema in association with a subphrenic abscess. If there is no gas-bubble, then it may be impossible to tell whether a subphrenic abscess is present in addition to the empyema. Accordingly treatment proceeds as if the empyema were uncomplicated, and it is drained at the correct time. If now there is a direct communication through the diaphragm between the subphrenic abscess and the empyema, the former may drain satisfactorily through the chest wound. If there is no such communication, and the empyema arose as the result of infection of a sympathetic effusion, then the very existence of the subphrenic abscess may remain unsuspected until it becomes obvious that the symptoms are not abating as a result of drainage of the empyema. This being so, radio-opaque material is introduced into the empyema cavity and it is found on X-raying the chest that the diaphragm is raised. The subphrenic space is then explored and drained through a separate incision.

CHAPTER VII

THE ABDOMEN (PART TWO)

I. THE STOMACH AND DUODENUM

Perforated Peptic Ulcer

THE immediate post-operative treatment of perforations of the stomach and duodenum is discussed above (p. 113), when dealing with peritonitis. A scheme is outlined for the day-to-day treatment of perforations associated with peritonitis, and there follows a short account as to how this scheme may be modified in perforations operated upon within the first few hours and before peritonitis has appeared. It is now necessary to consider the treatment of such a case apart from the immediate anxieties of the first fourteen days. We may assume that the bogey of peritonitis has been exorcised and that, by a judicious use of drainage tubes and the adoption of the Fowler position, residual abscess has *been prevented*

It must be borne in mind that the patient is still the possessor of a peptic ulcer and, perhaps more important, that those factors which produced the ulcer in the first place are still operating. It is quite true that, without any attempt to control these factors, the symptoms of peptic ulceration are often in abeyance for as long as a year or more after the accident of perforation. The reason for this is not clear, but it is almost certain that, unless measures are taken to control the ulcer-producing factors, sooner or later symptoms will reappear and the treatment may then be more prolonged and tedious.

Usually after about five to seven days from the time of repairing the perforation, the patient adopts the following regime :

8 a.m. (1) Atropine sulphate, gr. $\frac{1}{100}$ } Mixture A.
Water, ʒ i

(2) Sodium citrate, gr. x } dissolved and added to : } Mixture B.
Water, ʒ i
Milk, ℥ v (warm or cold)

8.30 a.m. 1. Magnesium trisilicate, ʒ ss.
2. Strained orange-juice, ℥ i.

9 *a.m.* (1) Olive-oil, ℥ ss.
(2) Arrowroot, junket or custard, ℥ v to which may be added fruit-jelly. } C.
(3) A rusk with butter.
9.30 *a.m.* Magnesium trisilicate, ʒ ss.

10 *a.m.* Mixture *B.*
10.30 *a.m.* Magnesium trisilicate, ʒ ss.

11 *a.m.* *C*, plus cream, ℥ i.
11.30 *a.m.* Magnesium trisilicate, ʒ ss.

12 *noon.* Mixture *B.*
12.30 *p.m.* Magnesium trisilicate, ʒ ss.

1 *p.m.* (1) *C*, plus cream, ℥ i.
(2) A rusk with butter.
1.30 *p.m.* Magnesium trisilicate, ʒ ss.

2 *p.m.* (1) Olive-oil, ℥ ss.
(2) Mixture *B.*
2.30 *p.m.* Magnesium trisilicate, ʒ ss.

3 *p.m.* (1) Mixture *A.*
(2) Thick soup or semi-solid purée of potato, artichoke, cauliflower or parsnip, ℥ v.
3.30 *p.m.* 1. Magnesium trisilicate, ʒ ss.
2. Strained orange-juice, ℥ i.

4 *p.m.* Mixture *B.*
4.30 *p.m.* Magnesium trisilicate, ʒ ss.

5 *p.m.* *C*, plus cream, ℥ i.
5.30 *p.m.* Magnesium trisilicate, ʒ ss.

6 *p.m.* Mixture *B.*
6.30 *p.m.* Magnesium trisilicate, ʒ ss.

7 *p.m.* (1) Olive-oil, ℥ ss.
(2) Thick soup, or semi-solid purée of potato, artichoke, cauliflower or parsnip, ℥ v.
(3) A "coddled egg" and some thin bread and butter (without crust), which must be well chewed.
7.30 *p.m.* Magnesium trisilicate, ʒ ss.

8 *p.m.* (1) Mixture *B.*
(2) A rusk with butter.
8.30 *p.m.* 1. Magnesium trisilicate, ʒ ss.
2. Strained orange-juice, ℥ i.

9 *p.m.* *C.*
9.30 *p.m.* Magnesium trisilicate, ʒ ss.

10 *p.m.* (1) Mixture *A*, 2 doses.
(2) Mixture *B*.
10.30 *p.m.* Magnesium trisilicate, ʒ i.

A glass of Mixture *B* should be placed at the bedside so that the patient may sip a few ounces in the night.

No smoking is allowed.

Small quantities of water may be allowed as desired.

The mouth must be washed out after each feed and attention paid to keeping the tongue clean.

This regime should be adhered to for at least a month and for the first three weeks the patient must be confined to bed. After the first fortnight the stools should be tested weekly for occult blood, and when two consecutive specimens have been found free from blood the patient may progress to the further stages of treatment. Any return of symptoms or the reappearance of occult blood in the stools, for which tests must be made periodically, demands that the patient should return to the above strict regime. The second stage consists in spacing the feeds at two-hourly intervals with a corresponding increase in bulk of each feed and giving the magnesium trisilicate only between these more widely spaced feeds. This modified regime is continued for a further fortnight provided the stools remain free from occult blood.

At the end of this period the diet may gradually be enriched by the addition, first of all, of boiled eggs, steamed fish and bread and butter; later by minced chicken and mashed potato, porridge and fried foods.

Smoking should be cut down to the minimum and should only be indulged in immediately after a meal. Attention must be paid to sources of sepsis within the mouth, throat and nose, and frequent X-ray photographs of the stomach and duodenum should be taken to confirm the healing of the ulcer.

The following instructions are issued to the patients at Guy's Hospital, and are reproduced by the kind permission of my colleagues on the Staff.

POST-ULCER REGIME

To be followed Permanently

Avoid alcohol. Avoid effervescing drinks and coffee.

Avoid all pips and skins of fruit (whether raw, cooked or in jam) and currants, raisins and lemon-peel in puddings and cake, nuts and all

unripe fruit. For example, an orange may be sucked but not eaten. Currants, raisins and figs are particularly undesirable.

Avoid all raw vegetables, whether taken alone (celery, watercress), or in pickles or salad; green vegetables must be passed through a sieve and mixed with butter in the form of a purée. Porridge is allowed only if made with the finest oatmeal.

Avoid vinegar, lemon-juice, sour fruit, spinach, pepper, mustard, curry, chutney, excess of salt, new bread, tough meat. During the first six months after recovery from an ulcer it is best to avoid butchers' meat altogether.

Take plenty of butter, and a tablespoonful of olive-oil before each meal.

Eat slowly and chew very thoroughly. An adequate time should be allowed for meals, and rest for at least a quarter of an hour before and after meals. Meals must be punctual.

Don't smoke excessively. No smoking at all if any indigestion.

For Six Months.—A meal or feed should be taken at intervals of not more than two hours from waking till retiring, and again if awake during the night. The feed should consist of a glass of the following mixture, which should be prepared each morning: a quart of milk and 120 grains of sodium citrate in 1 oz. of water.

After Six Months of Complete Freedom.—A feed should be taken in the middle of the morning, on going to bed, and again if awake during the night, in addition to the ordinary meals.

A teaspoonful of magnesium trisilicate should be taken an hour after meals, on going to bed, and also directly the slightest indigestion or heartburn is felt.

The bowels should be kept regular by means of magnesia emulsion or liquid paraffin, but no other aperients should be taken.

The teeth should be attended to by the dentist regularly every six months.

No drugs should be taken in pill or tablet form.

If there is the slightest return of symptoms, the patient should go to bed on a strict diet, consult his doctor, and not wait for the symptoms to get serious.

Gastrectomy and Gastro-enterostomy

After the operations of gastrectomy and gastro-enterostomy the patient is sometimes severely shocked. The operation in such cases is one which is not usually attended by much loss of blood and the patient's condition is due, especially after gastrectomy, to the prolonged exposure and unavoidable cooling of the intestines

and to traction on the mesentery. Accordingly the intravenous infusion of a pint or more of plasma may be necessary if the systolic blood-pressure is below 90 mm. of mercury. Blood is equally as effective, but is not specifically indicated unless the operation has been attended by an unusual amount of hæmorrhage. In addition to intravenous infusion in patients suffering from shock, and as a routine in all other cases, a rectal drip infusion should be set up to deliver 4 pints of 5 per cent. glucose in tap-water in twenty-four hours. If there is any difficulty in retaining this amount, the infusion may be clipped off and the rectum rested for two hours, after which time a further quantity may be absorbed. If the rectum cannot retain adequate volumes of fluid, then an intravenous infusion of sterile 5 per cent. glucose must be substituted. It is not usually necessary to give fluids either by the rectum or intravenously after the first thirty-six hours, as by this time the patient should be able to take sufficient by the mouth.

Diet

The following scheme of feeding has been found satisfactory, although the somewhat prolonged abstention from solid food may lead to flatulence, which can be controlled by charcoal biscuits and the use of the flatus tube.

The Day following the Operation.—Boiled water ℥ i hourly for twelve hours.

A mixture of equal parts of boiled water and citrated milk ℥ i hourly for the next twelve hours.

2nd Day—Citrated milk and water ℥ ij hourly. A glass of water is put by the bed and the patient is instructed to sip this as desired.

3rd Day—A mixture containing 2 parts of citrated milk to 1 part of water ℥ iij hourly.

4th Day.—Citrated milk ℥ iv hourly

5th Day.—Citrated milk ℥ v hourly.

6th Day.—Ovaltine, Horlicks or weak tea may be substituted for the citrated milk and a rusk may be taken with each feed, together with a charcoal biscuit if necessary.

7th Day.—A light diet consisting of bread and butter, a lightly boiled egg, jellies, custards, etc.

8th Day.—Potato, steamed fish, etc.

10th Day—Boiled fish. Chicken, etc.

Great care must be taken to keep the mouth clean, and the patient often derives benefit from sucking Rowntree's gums and rinsing out the mouth with soda-water.

Usually the patient is fit to get up on about the 14th day, but elderly patients may benefit by being allowed to sit up in an arm-chair earlier than this (p. 17).

The further conduct of these cases depends upon a variety of circumstances. The operations of gastrectomy and gastro-jejunostomy are, with the exception of certain cases of neoplasm, designed ideally to allow the patient to lead an absolutely normal life in full enjoyment of complete health. Unfortunately these ideals are rarely attained and some restrictions are usually necessary if the patient is to avoid dyspepsia. A good plan is to base the diet of these patients after the fourteenth day on the instructions issued to patients on " the post-ulcer regime " (p. 130). Certain modifications of this regime are allowable in regard to diet, and it may be found, as the result of the method of trial and error, that a patient who has had gastrectomy or a gastro-jejunostomy may eventually take a full diet without any restriction. The medicaments (olive-oil, magnesium trisilicate, etc.) prescribed in this scheme should not be necessary.

COMPLICATIONS

Certain complications of gastrectomy and gastro-jejunostomy such as *peritonitis*, *subphrenic abscess* and *chest complications* are not peculiar to these operations and are discussed elsewhere. There are, however, certain complications to which these patients are especially liable. In regard to *peritonitis* after gastric operations it must be assumed that this condition has arisen as a result of faulty technique and the establishment of a leak at the suture-line. Accordingly, although the general principles of treatment of post-operative peritonitis from other causes are conservative, here no time should be lost in opening the abdomen, repairing the defect in the suture-line and draining the peritoneum. The regime for the treatment of peritonitis (p. 113) should then be instituted.

VOMITING

Vomiting after gastrectomy (other than post-anæsthetic vomiting, and if of more than a trivial degree) must be treated by setting up a gastric suction apparatus (p. 12) and the institution of an intravenous drip (4 pints of 5 per cent. glucose in distilled water and 2 pints of normal saline in the twenty-four hours). If the vomiting was due to *œdema* obliterating the stoma, the gastric contents will not be markedly bile-stained and may soon diminish in quantity. The gastric suction and intravenous drip are dispensed with as soon as the indications discussed on page 119 (*b*) obtain. If the vomiting was due to *paralytic ileus*, then the gastric contents will be bile-stained

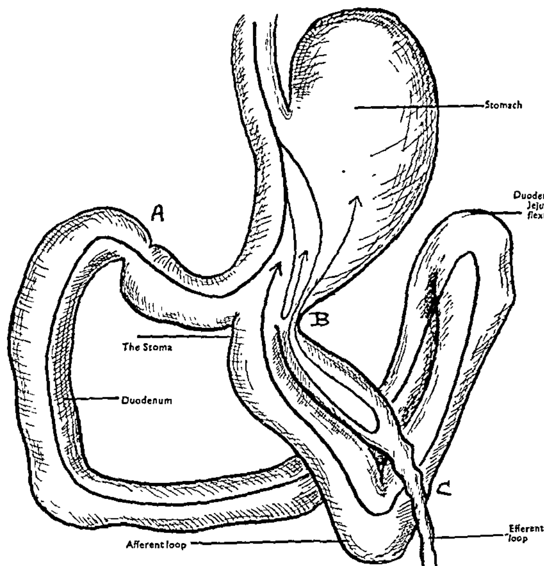


FIG 17.—" Vicious-circle " vomiting.

A Most of the food is leaving via the pylorus instead of through the stoma.
B There is obstruction to the efferent loop at the stoma due to bad placing. Œdema might render this obstruction absolute
C. A long loop has been used and the efferent part is obstructed.

and, later, brown and foul-smelling. After a time the material from the stomach lessens in quantity and becomes more normal in quality. When this has occurred, and as soon as peristaltic sounds become audible with the stethoscope, the gastric tube is clipped off and test feeds are given, the subsequent management being the same as that described on page 132. Gastro-enterostomy is liable to be followed by the same complications, and these are treated in the same way,

but it is in addition subject to the complication of "vicious-circle" vomiting due to fluid leaving the stomach by the pylorus and re-entering it by the stoma (Fig. 17), and also acute gastric dilatation (p. 12) may rarely occur.

In *vicious-circle vomiting* the gastric contents are bile-stained so that paralytic ileus may be suspected, but they never become brown or "fæculent". The treatment is at first as for paralytic ileus (with which it may at this time be confused), that is gastric suction is instituted and an intravenous drip is set up. The condition may soon settle, in which case the diagnosis as between paralytic ileus which has aborted and "vicious-circle vomiting", due to œdema completing the obstruction in a somewhat unsatisfactorily placed efferent loop, may never be made. If, however, the volume of material aspirated does not lessen, although never becoming brown and "fæculent", then the diagnosis of vicious-circle obstruction can be made with confidence and the abdomen must be reopened. Either a fresh stoma is fashioned or an entero-enterostomy performed between the afferent and efferent loops. With the modern short-loop posterior gastro-enterostomy, vicious-circle vomiting is exceptionally rare.

Occasionally the symptoms of vicious-circle vomiting (i.e. persistent vomiting of bile-stained fluid not becoming "fæculent") may be accompanied by severe epigastric pain and collapse. In these circumstances *intussusception* of the jejunum through the stoma may have caused complete gastric obstruction. This complication can occur at any time after a gastro-enterostomy and immediate operative treatment is called for.

HÆMORRHAGE

The vomiting of small quantities *of blood-stained material* is not uncommon after gastric operations. Occasionally large quantities of blood are vomited or other signs of severe internal hæmorrhage such as pallor, a rising pulse-rate and restlessness may appear. In these circumstances the patient should be given a full dose of morphia and ice may be sucked. Hunger contractions do not take place in the stomach which has just been subjected to an operation, so that the Meulengracht technique of allaying these spasms by giving food by the mouth has no place in the treatment of post-operative gastric hæmorrhage On the other hand the presence of large quantities of blood or blood-clot in the stomach may excite contractions and the stomach should therefore be washed out, using a soft-walled Ryle's tube. Ten minims of adrenalin (1 : 1,000) are sometimes injected into the stomach at the conclusion of the washing out. If the symptoms of hæmorrhage

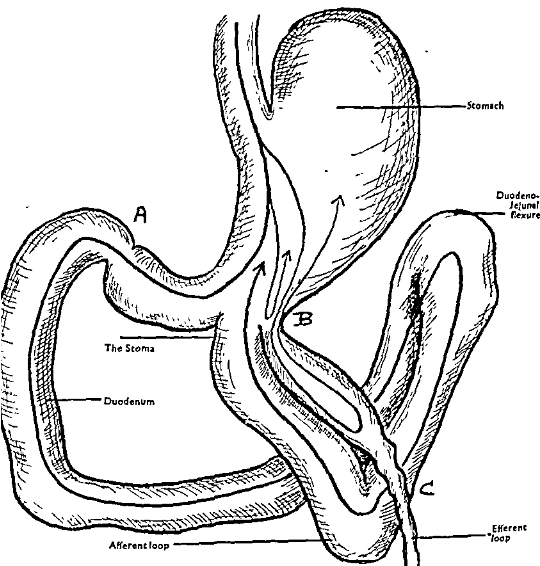


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there is achlorhydria—by the prescription of Acid. Hydrochlor. Dil. ʒ ij in a tumblerful of water before each meal.

RECURRENCE OF SYMPTOMS

The reappearance of gastric symptoms following gastrectomy or gastro-jejunostomy for ulcer, however much these symptoms may mimic the pre-operative ones, usually means, not that the old ulcer has recurred, but that a fresh ulcer has formed at the stoma or in the jejunum. The treatment of these ulcers constitutes one of the most difficult problems of therapeutics and it is not intended to enter into that problem here. The case must be investigated radiologically, by test meal, by examination for occult blood in the stools, and if possible by gastroscopy. After a period of conservative treatment on the lines suggested for the after-treatment of perforated peptic ulcer (p. 128), the decision may have to be made between performing a further risky operation with only a moderate chance of success or condemning the patient to a life of invalidism.

Perigastric abscess and *gastro-jejuno-colic fistula* are rare complications of gastro-enterostomy.

Gastrostomy

DIET

On the day of the operation for gastrostomy the patient should be given an equal mixture of 5 per cent. glucose and normal saline, ℥ v every two hours, through the gastrostomy tube. In cases where the dehydration has been severe this volume of fluid may not be tolerated by the intensely contracted stomach, and if it gives rise to epigastric discomfort the volume can be reduced to ℥ iij every two hours, the balance being made up by rectal infusion.

1st Day following the Operation.—Milk ℥ v every two hours.

2nd Day.—Gruel, egg and milk, Ovaltine, Horlicks, Bovril or thick soup ℥ v every two hours.

3rd Day.—℥ viij of the above every three hours.

7th Day.—℥ x–xv four-hourly. Soups are flavoured with Marmite and the juice of one or two oranges is added each day, and by these means the vitamin requirements are ensured. Constipation is treated by paraffin run in through the gastrostomy tube night and morning.

MANAGEMENT

These patients, most of whom are elderly and suffering from the cachexia of a carcinoma of the œsophagus, are notoriously liable to

continue, and of these the most important is a rising pulse-rate, then the abdomen must be opened and the source of the hæmorrhage sought. This is usually in the suture-line, which can be inspected on its internal surface, at least in the case of gastro-enterostomy, by making a separate opening into the stomach alongside the anastomosis and everting the anastomosis through this. It may be possible to pick up and ligature a definite bleeding point, or if the bleeding is general from the suture-line, this can be reinforced by a continuous suture passing through all layers.

The very nature of the operation of gastrectomy, whereby all the main blood-vessels are ligatured proximal to the anastomosis, makes intragastric bleeding which cannot be controlled by conservative measures practically unknown after this operation. If uncontrollable internal bleeding occurs after gastrectomy, it is almost certainly outside the stomach and jejunum, and is probably from the left gastric or a branch of the gastro-duodenal artery. Blood transfusion will often be required after the source of the bleeding has been controlled.

"Plumping" Stoma

Symptoms may arise after gastro-jejunostomy because there is too large a stoma. The food passes quickly through the stomach and reaches the jejunum in a bulky and undigested state. The patient will complain of epigastric or peri-umbilical discomfort and distension after meals and there is a tendency to diarrhœa. Because of deficient absorption of iron and of vitamins, anæmia may develop which is usually of the microcytic type and responds to iron therapy but may require liver in addition, or peripheral neuritis from vitamin B deficiency may occur. Occasionally calcium absorption is deficient and this may lead to œdema, urticaria or amenorrhœa. If symptoms cannot be controlled conservatively a fresh stoma may have to be made.

Anæmia and Vitamin Deficiency

Anæmia following gastro-jejunostomy sometimes complicates a case where the stoma is of the correct size. The cause is then a gastritis which likewise interferes with the production of the blood-forming factors Neurological symptoms and signs of vitamin B deficiency such as peripheral neuritis may appear as in the case of "plumping stoma", but the discomfort is epigastric rather than peri-umbilical and an X-ray picture shows a normally functioning stoma. In these cases the anæmia must be corrected with iron or liver, vitamin preparations are prescribed, and the gastritis treated by attention to diet and—if

the opening is left "unoccupied", the surrounding skin should be gently washed with soap and water, dried and powdered.

Often the obstruction in the œsophagus will be so relieved as a result of the gastrostomy that, although it be due to a carcinoma, the patient may find that he can drink tea and even swallow bread and butter provided this is well chewed. These exercises cannot do much harm and as they allow him to enlarge his social activities they may well be indulged. The calorific and vitamin content of the diet must be satisfactory. Soups, milk foods, sweetened drinks, fruit-juice and Marmite should provide for this (Appendix II). A full and interesting discussion on the dietary requirements of these patients will be found in the *British Journal of Surgery*, 1937, 24, 749, by E. S. J. King. In this account the suggestion is made that semi-solid material should be fed to these patients by means of a grease-gun, so that the stomach may have something more satisfying to work on.

COMPLICATIONS

Intraperitoneal leakage may occur if the stomach breaks free from the anterior abdominal wall. This sometimes happens spontaneously, particularly when the operation has been performed, not for carcinoma of the œsophagus, but for carcinoma of the cardiac end of the stomach. The presence of a neoplastic process inside the peritoneal cavity appears to check the natural plastic peritonitis which usually anchors the stomach firmly to the anterior abdominal wall, and in such cases the surgeon would be well advised to stitch the stomach to the abdominal wall with silk. The symptoms are those of acute or sub-acute perforation of a gastric ulcer and this complication demands immediate operation. The prognosis in these debilitated patients is naturally very bad. *Stenosis* of the fistula should not occur if the patient follows the instructions and never allows the opening to remain unoccupied for more than a few minutes. There may be the greatest difficulty in replacing the tube in these circumstances and resort may have to be made to dilating the opening with a metal urethral bougie. This must be done with the very greatest care, otherwise intraperitoneal leakage is likely. If there is any real difficulty it is far safer to refashion the gastrostomy opening under a local anæsthetic. *Skin excoriation* around the orifice is best treated with aluminium paste (p. 149) or Vaseline.

chest complications. They should be allowed up on the third or fourth day at the latest, whilst many can be got up on the day following the operation. A mixture containing tincture of belladonna ♏ vij should be prescribed three times a day.

On the tenth day the stitches are removed and the tube is changed. For the next week, whilst the patient is still in the nursing home or hospital, two tubes may be used alternately each day. Before he is discharged he should be supplied with a gastrostomy tube and belt together with a solid rubber bougie about three inches in length (Fig. 18). This bougie is inserted into the gastrostomy opening which it keeps

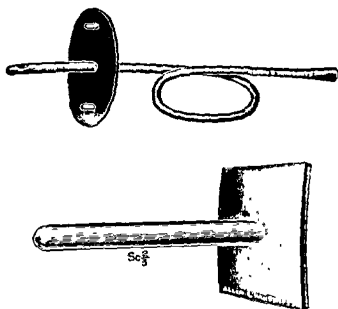


FIG. 18—Gastrostomy tube and bougie

patent and is retained in the abdominal wall by means of a flange. The patient should be instructed how to insert this, and should be warned that he must never allow the gastrostomy opening to remain "unoccupied" either by the gastrostomy tube or by the rubber bougie for more than ten minutes at a time, otherwise it may contract and he may be unable to reinsert them.

The procedure which he is to adopt is therefore as follows. The rubber bougie and gastrostomy belt are worn day and night. At meal times the bougie is removed and the gastrostomy tube substituted. At the end of the meal the bougie is replaced. At least once each day the bougie and the gastrostomy tube should be cleaned and immersed in boiling water for three minutes. Each day, while for a few minutes

brought out through the abdominal incision. This drain serves to prevent biliary peritonitis by giving egress to bile which may leak from the cystic stump or seep from the raw liver surface in the gall-bladder bed. Its withdrawal, which may begin after forty-eight hours, is managed with this consideration in view, the tube being retained as long as there is any discharge of bile from the wound. After a simple cholecystectomy the patient is usually fit to get up in a fortnight.

If the common-duct has been explored then, in addition to the above drain, a tube will have been sewn into this duct and this tube is connected to a receiver containing antiseptic solution under the bed. The volume of bile secreted in the twenty-four hours is charted and should amount to 500–1,000 c.cm. unless the fæces are very well coloured, indicating that much bile is escaping into the intestinal tract.

Biliary Fistula

The tube in the common-duct is withdrawn after twelve days, and provided the common-duct is unobstructed the resulting fistula heals quite quickly. Until this occurs the skin round the fistula should be treated with aluminium paste (p. 149) or zinc and castor-oil ointment, and a pad of absorbent wool placed over the part. If this *fistula persists*, it means that there is some undetected *obstruction* hindering the bile from taking its proper course. If the fæces are coloured, then this obstruction is *incomplete*, and the patient is treated *expectantly*, the fistula usually closing spontaneously in the course of weeks or months. If the fæces are quite unstained by bile, then the obstruction is *complete* and the patient must have an *operation* to overcome the obstruction. Complete obstruction would be most unusual after an operation on a patient who was not jaundiced. In complete or practically complete biliary fistula the patient rapidly goes downhill from inanition, the digestive functions being seriously impaired by deprivation of bile. In these circumstances a tube fitting snugly into the fistula is inserted and the bile collected by siphonage or by connecting the tube to a gastric suction apparatus. The collected bile is then fed to the patient by means of a duodenal tube.

Biliary Peritonitis

[illegible]

if a [illegible]

to [illegible] usually the bile seeps all over the peritoneal cavity, giving rise to acute aseptic peritonitis. Some of the usual symptoms and signs

II. THE BILIARY SYSTEM

General Principles

Two operations are commonly performed on the biliary system, namely cholecystectomy and cholecystostomy. The former is the more usual and both may be associated with exploration and drainage of the common bile-duct if the indications require it. These operations are liable to the complications arising after any operation on the upper abdomen, particularly chest complications (p. 88), and they also present problems peculiarly their own.

As after all severe operations the fluid intake should reach at least 6 pints in the twenty-four hours, and if it is not possible to give this volume of fluid by the mouth, as may be the case in the first day or two, then rectal infusion of 5 per cent. glucose in tap-water or intravenous infusion of sterile 5 per cent. glucose solution must be given to supplement this *A dose of senna is given on the evening of the third day* and an enema on the following morning. During convalescence from all operations on the biliary tract, patients should take large doses of glucose in the form of sweetened drinks to promote glycogen storage. For the first four weeks at least, and for as long afterwards as symptoms persist, they should be on a low fat, high carbohydrate diet. Chocolate and eggs should be avoided altogether, and each morning a dose of magnesium sulphate ʒ ij should be taken.

Cholecystostomy

After cholecystostomy a tube will have been inserted and stitched into the gall-bladder, and this tube is connected to a receiver containing antiseptic solution under the bed. In addition the operation field may have been drained by a second tube. The tube in the gall-bladder comes away spontaneously after about the twelfth day and provided the common-duct is unobstructed the biliary fistula heals in a few days. (For the treatment of persistent fistula see below.) The second drain is removed slowly after forty-eight hours, depending upon the amount of the discharge. The patient is usually fit to get up when the gall-bladder drain has been removed on the twelfth day, and this increased activity encourages closure of the fistula.

Cholecystectomy

After cholecystectomy, except in unusually favourable circumstances, a drain is passed down to the stump of the cystic duct, lying under the gall-bladder bed on the under surface of the liver, and is

brought out through the abdominal incision. This drain serves to prevent biliary peritonitis by giving egress to bile which may leak from the cystic stump or seep from the raw liver surface in the gall-bladder bed. Its withdrawal, which may begin after forty-eight hours, is managed with this consideration in view, the tube being retained as long as there is any discharge of bile from the wound. After a simple cholecystectomy the patient is usually fit to get up in a fortnight.

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Biliary Peritonitis

Biliary peritonitis should be a rare complication of these operations if a drainage tube is used as a routine. It is uncommon for localisation to occur, and usually the bile seeps all over the peritoneal cavity, giving rise to acute aseptic peritonitis. Some of the usual symptoms and signs

of peritonitis—pain, abdominal rigidity and "guarding"—may be absent, but the patient is collapsed, the pulse rapid and thready, the abdomen distended and there is vomiting. These symptoms and signs after another type of abdominal operation would suggest paralytic ileus for which the treatment might well be conservative. After operations on the biliary tract, however, unless it is absolutely certain that there is no possibility of escape of bile, the abdomen should be opened and the *peritoneum drained both in the pouch of Douglas* and from the site of biliary escape. The after-treatment of peritonitis (p. 113) should then be instituted. On one occasion, four days after cholecystectomy, I encountered a case giving the above signs in whom in addition there was an ill-defined mass in the supra-umbilical region. This was explored and found to be a localised collection of bile, and following drainage of this the patient made an uninterrupted recovery.

Injury to the Common-duct

Damage to the common-duct at the time of the operation leads to obstructive jaundice (when the common-duct is ligatured in mistake for the cystic-duct or a loop of lax common-duct is included in this ligature) or to biliary fistula. If *complete obstruction* follows the operation, as is evidenced by the absence of bile from the stools, then an *operation* must be undertaken forthwith to repair the damage or at least to overcome the obstruction. A tinge of jaundice after operations on the biliary system is very common and is probably due to œdema of the ducts; but severe jaundice, even though there is incomplete obstruction as evidenced by the stools being coloured, should be watched only for a short time and, if it does not abate within a few days, an operation must be undertaken to repair the damage to the common-duct or to drain away the bile. If a fistula appears, then it is treated according to the principles outlined above.

Recurrence of Symptoms

Recurrence of symptoms of stone in the common-duct, whatever the pathology of this may be—and there appears to be some doubt—demands a fresh exploration of the common-duct after a short trial of medical treatment.

Operations on Jaundiced Patients

In the presence of jaundice, all the above considerations apply after operations on the biliary tract, but there are additional difficulties and dangers.

HÆMORRHAGE

Hæmorrhage has probably been exaggerated as a risk in jaundiced patients. Undoubtedly, however, the danger of hæmorrhage is greater in jaundiced than in non-jaundiced patients and the surgeon will have taken particular care at the time of the operation to forestall this complication. If it arises, the bleeding generally takes place into the abdominal wall and a large hæmatoma appears which will have to be evacuated. Intra-abdominal bleeding should at once become apparent through the drainage tube and the general measures for the arrest of hæmorrhage are adopted (p. 47). If these fail to control the bleeding, the wound will have to be reopened and the bleeding point looked for and tied or the area plugged with gauze. This gauze can safely be removed under Pentothal anæsthesia in forty-eight hours' time.

In addition to the general measures for preventing hæmorrhage, there are for jaundiced patients additional safeguards which should be used pre- and post-operatively. They are:

(*a*) Vitamin K. This may be administered as follows:

Kapilon (Glaxo) 1–2 c.cm. (by subcutaneous or intramuscular injection) daily for three days before the operation, and 1 c.cm. daily for three days after the operation; or

Klotogen (Abbott) 1 capsule (1,000 units Alinquist standard) plus 2 Bilein capsules (sodium glycocholate and sodium taurocholate) three times a day by mouth for four days before operation, and if necessary for two or three days after operation.

As oral administration may be impossible after operation, Kapilon by injection is to be preferred.

(*b*) 5 c.cm. of *calcium lactate* 10 per cent. (a suitable preparation being Calcium Sandoz) may be injected intravenously pre- and post-operatively.

(*c*) *Transfusion of blood* by the drip method or repeated small transfusions may be of value in these cases. The injection of 10 c.cm. of the patient's own blood intramuscularly into the buttock has its advocates.

DISAPPEARANCE OF THE JAUNDICE

In operating on jaundiced patients the principal object is to relieve the jaundice, and this may take a disappointingly long time. After severe obstruction it is unusual for the jaundice to disappear under six weeks, however successful the operation may have been, and patients should be warned of this to prevent disappointment. Fortunately the irritation of the skin is the first symptom to disappear. In the meanwhile the patient must be enjoined to refrain from scratch-

ing and given Unguentum Calaminæ to apply to the irritable parts The dry extract of thyroid, in doses of a grain twice a day, sometimes helps to control the itching, and massive doses of glucose are given to preserve liver function.

PROGNOSIS

The prognosis of operation upon jaundiced patients is not good Their resistance is undermined by the toxicity that the cholæmia occasions and the inevitable sudden release of the obstruction may cause the liver function to fail. The appearance of "*white bile*" has a particularly sinister significance in this respect, and usually indicates irrecoverable failure of liver function. In discussing operations for the relief of obstructive jaundice, Fraser (*British Journal of Surgery*, 1938, **26**, 393) describes two causes of death: *liver death*, which comes on within forty-eight hours and is characterised by hyperpyrexia, vomiting, hæmatemesis and coma; and *renal death*, which is accompanied by listlessness, vomiting, oliguria and the appearance of blood and casts in the urine, and occurs in four or five days after the operation. These two syndromes can be distinguished from biliary peritonitis, the first by the hyperpyrexia and the second by the urinary changes. The routine treatment with massive doses of glucose and fluid is all that can be done to help to ward off these lethal complications.

SHORT-CIRCUIT OPERATIONS

In carcinoma of the head of the pancreas or in chronic pancreatitis, after operations to by-pass the obstructed bile-duct such as *cholecyst-gastrostomy* or *cholecyst-enterostomy*, there will be a large volume of bile poured out into the stomach or intestine. After cholecyst-gastrostomy a gastric suction apparatus should be set up for at least forty-eight hours to prevent acute gastric dilatation which these large quantities of bile are apt to cause. After cholecyst-enterostomy this tendency is not so marked, but there is for the same reason a similar though not so great a likelihood of paralytic ileus developing, and this is not so easy to control. *Intravenous fluid* is essential for forty-eight hours or more following these operations, as large volumes of fluid are required and the rectum must be reserved for its proper function of voiding fæces and flatus Liver failure is particularly common and the treatment outlined above must be instituted in all cases.

CHAPTER VIII

THE ABDOMEN (PART THREE)

I. THE INTESTINES

Intestinal Resection

INTESTINAL resections are of two types—intra-abdominal and extra-abdominal. *Intra-abdominal or "closed" resection* is done inside the peritoneal cavity, the continuity of the gut is restored by anastomosis and the abdominal wound completely sewn up. This type of resection is usually performed only as a set operation in the absence of intestinal obstruction. Rarely it is performed in the presence of acute obstruction, but only when that obstruction has not been preceded by chronic obstruction and usually when the site of the obstruction is the small intestine, e.g. in certain operations for strangulated hernia.

In extra-abdominal or "open" resection which may be performed in the presence or absence of acute obstruction, the loop of bowel to be removed is brought out of the abdomen through the laparotomy incision which is sewn up except where the bowel protrudes, or the bowel is brought out through a separate small incision and the laparotomy wound completely closed. In the latter event a "watershed dressing" should be used to separate the two wounds. The watershed dressing (Fig. 19) consists of two pieces of strapping four inches wide and

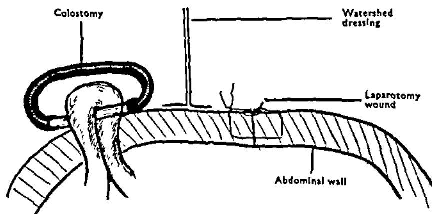


FIG. 19.—The "watershed dressing" separates the colostomy from the laparotomy wound.

six inches long. The two pieces are stuck together, sticky side to sticky side, except for a margin of half an inch along one side of each which is turned back as a flange. The flange is then applied to the abdominal wall between the two wounds and the two pieces of strapping stand up as a wall which can be folded over the laparotomy wound, and thus serve to occlude this completely from the enterostomy.

The loop of bowel is excised on the surface of the abdomen only after the major part or, where two incisions have been used, the whole of the laparotomy wound has been occluded by a collodion dressing. A Paul's tube (Fig. 21) is tied into the proximal segment of the bowel and a clamp is put on the distal segment. This clamp gradually erodes the wall of the intestine and falls off spontaneously on the sixth or seventh day. Sometimes Paul's tubes are tied into both segments. Occasionally, when there is no obstruction, resection of the loop may be deferred until the following day and can be performed under a local anæsthetic. This practice, however, is open to the same objections as the late opening of a colostomy (p. 155), and is even more undesirable in that the performance is seldom free from pain, and is attended by much hæmorrhage from the œdematous mesentery, which is difficult to control. It should not, therefore, be adopted unless the condition is one of strangulated hernia and the loop has been left outside the abdomen for observation.

Resection of small intestine is nearly always intra-abdominal, whether acute obstruction is present or not. Occasionally, however, in cases of strangulated hernia where a loop of small intestine is of doubtful viability, it may be left outside the abdomen covered with paraffin-soaked sponges and observed for twenty-four hours, by which time it is obvious whether it is going to live or die and, if necessary, resection can be carried out or, if it is viable, the loop may be returned to the abdomen.

"Closed" Resection without Obstruction

The after-treatment of intra-abdominal resections unassociated with obstruction does not differ from that after any major abdominal procedure

Fluids

Fluid can usually be taken by the mouth within a few hours and only one or, at the most, 2 pints of fluid (5 per cent. glucose in tap-water) are needed per rectum. The first of these pints contains 30 grains of potassium bromide. If, however, the resection

splenic flexure, fluid by the rectum should be withheld and, if fluid in addition to that which is taken by the mouth be required, then it should be given into a vein.

Safety Valve

In most cases of resection of the large intestine within the abdomen a colostomy or a cæcostomy will have been performed previously, proximal to the anastomosis. This is done in order to relieve tension on the suture-line and no resection of the left side of the colon should be without some such safety valve. If the resection is low in the pelvic colon, however, and if there is no obstruction, tension on the suture-line may be relieved by passing a tube through the rectum, past the anastomosis and into the segment of intestine above. This tube is left in for five days or until abdominal distension has subsided. It is a source of some discomfort which may be mitigated to a certain extent by lubricating the anus and that part of the tube which lies in the anus with Decicaine ointment 2 per cent. Twice a day 3 ounces of paraffin or olive-oil are run into the tube.

"Closed" Resection with Obstruction

Fluids

Where there has been acute obstruction associated with vomiting, then it is wise to institute gastric suction and to put up an intravenous drip-infusion apparatus delivering 4 pints of 5 per cent. glucose in distilled water and 2 pints of normal saline every twenty-four hours. After acute obstruction, fluid by the rectum is unsuitable because of the tendency to paralytic distension which may be aggravated by rectal infusion and because it precludes the use of the rectum for its physiological function of voiding gas and fæces, a function which may be urgently needed. Where the apparatus for intravenous infusion is not available, fluid must be given by the rectum in very small quantities at a time. Alternatively, if the practice is approved, the fluid may be given subcutaneously or intramuscularly by the drip method. After twenty-four or forty-eight hours fluid can generally be taken effectively by the mouth so that, after the usual preliminary trials [p. 119(*b*)], the gastric tube may be withdrawn and the drip-infusion apparatus taken down.

If the bowels have not worked, a dose of senna is given on the [illegible]

[illegible] section (p. 115).

"Open" Resections

Fluids

The after-treatment of extra-abdominal resections as far as fluid administration is concerned is in principle the same as for intra-abdominal resections, and depends upon whether acute obstruction was present before the operation or not. While, however, intra-abdominal resection is only rarely performed in the presence of acute obstruction, extra-abdominal resection frequently follows this condition.

When open resection is performed on an unobstructed bowel, fluid may be given by the mouth from the first day. Two pints of rectal fluid may be given by the drip method, starting immediately after the operation, as in closed resections, to tide the patient over the period of post-anæsthetic nausea and vomiting and as a suitable medium for the administration of potassium bromide (gr. xxx).

Where the operation has been preceded by obstruction, then, as in closed resections, a gastric suction apparatus is set up. In the case of open resection, however, the rectum is not required to void gas and fæces because the continuity of the alimentary tract has been interrupted at the resection, and gas and intestinal contents escape there. Especially is this so in the common large-bowel resections, where the segment of the bowel distal to the resection forms an ideal reservoir for infused fluid. Provided that the rectum will tolerate it, 8 or 10 pints of 5 per cent. glucose in tap-water are given per rectum in the first forty-eight hours; after which the patient should be able to take sufficient fluid by the mouth. If the rectum will not absorb this quantity, then it may be rested for two hours, when a fresh attempt should be made. If this is unsuccessful, then intravenous infusion must be practised.

In the rare open resection of small bowel, the distal segment may comprise a large proportion of the whole alimentary tract, and it is desirable to allow this segment to discharge freely through the rectum. Thus in these cases administration of rectal fluid, while not contra-indicated as after closed resection in the presence of obstruction, is unsuitable and an intravenous drip infusion should be used for the first twenty-four or forty-eight hours until adequate fluid can be taken by the mouth.

Fæcal Fistulæ

Small-bowel Fistula

Care of the Skin

It will be convenient to consider the care of small-bowel fistulæ from other causes together with that of the fistula arising from the extra-

abdominal resection of a loop of small bowel, as the problems are essentially the same. Jejunal and more particularly ileal fistulæ may have been made wittingly in order to overcome ileus or they may appear spontaneously after intraperitoneal infections which have been drained. If the jejunostomy or ileostomy is part of a planned surgical procedure, then a tube will have been sewn into the gut in a valvular manner and the junction between this tube and the bowel can generally be relied upon to remain water-tight at least for a number of days. Even in an extra-abdominal excision of a loop of small bowel it is usually possible to stitch a Paul's tube into each open end, or to stitch a Paul's tube into the proximal segment and clamp the distal segment so that leakage is put off for a day or two. Despite this it is wiser to adopt precautions to protect the skin of the abdominal wall from the digestive action of the intestinal juices from the first because, once excoriation has begun, it is very difficult to control. Various measures have been tried, such as painting the skin of the abdominal wall with rubber solution or dressing the part with oatmeal to absorb the digestive ferments, but by far the most satisfactory is the use of aluminium paste.

This paste—

℞	
Aluminium metal in powder	a.a. 1 part
Liquid paraffin . .	
Zinc ointment . . .	2 parts

is smeared liberally over the whole abdomen from the nipples to the pubis and out into the flanks, at the end of the operation or, in a spontaneous fistula, as soon as this is diagnosed. The paste is re-applied each day, and can be safely superimposed on raw areas, should they have appeared, without danger of toxic absorption. As soon as the enterostomy tube has come out or leakage has occurred, fine-quality absorbent wool should be used to soak up the discharge and this wool must be changed frequently. In some cases of persistent fistula a glass tube inserted into the fistulous opening and connected to a Sprengel's pump may drain the intestinal juices satisfactorily.

It must be remembered that enormous quantities of fluid may be lost from fistulæ of the small intestine, so that correspondingly vast quantities of fluid are required to prevent the patient becoming dehydrated and rectal or intravenous infusions are often necessary.

Closure

Usually within a short time of removal of the tube, fistulæ of the small intestine close spontaneously. This is particularly the case after

"Open" Resections

FLUIDS

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Fæcal Fistulæ

SMALL-BOWEL FISTULA

Care of the Skin

It will be convenient to consider the care of small-bowel fistulæ from other causes together with that of the fistula arising from the extra-

the enterotome will come away and most small-intestine fistulæ (or fistulæ of which one loop is small intestine and the other large intestine as after resections for carcinoma of the cæcum) will close spontaneously within a few days. If spontaneous closure does not occur, then an operation will be required.

Fistula of the Large Bowel including Colostomy

Care of the Skin

Fortunately fistulæ of the large intestine are not associated with skin excoriation except at first and to a trivial degree. The treatment, should signs of skin digestion appear, is to apply aluminium paste. The dressing of a large-intestine fistula should be designed to prevent soiling the abdominal wall with fæces, and this is particularly important in the case of a colostomy which is intended to be permanent, as the sight and smell of the uncontrolled escape of fæculent matter may cause the patient much distress. Certainly in the case of a colostomy (before this has been regulated—see section on Permanent Colostomy) and in most fistulæ the result of open resection of a loop of large bowel, it should be possible to prevent the abdomen from becoming soiled. A piece of gutta-percha tissue twelve inches square has a slit cut in one side. It is then applied around the colostomy and the slit is moulded close to the issuing bowel and sealed to the underlying skin with Vaseline. A cellulose pad is now placed over the fistula and the gutta-percha tissue folded neatly and firmly over this. After a motion has occurred, the whole dressing is withdrawn, still folded up, and discarded; the fistula is wiped and a fresh dressing applied. In the case of a colostomy with a rod through it, the gutta-percha envelope will need to be partly undone in order to negotiate the glass rod.

Bowel Action

The fistula may not discharge for two or three days, but if no motion has occurred by the fourth day, a dose of senna should be given and the proximal segment washed out with a pint of normal saline. Peritonitis and paralytic ileus, which may complicate these operations, are dealt with in a previous section, p. 112.

Closure

The problem with these fistulæ is to get them to close, and this is particularly the case with planned colostomies and fistulæ resulting from the extra-abdominal resection of a loop of large bowel where

a planned *enterostomy, but is not always so after a spontaneous fistula* and is the exception after the extra-abdominal resection of a loop of small intestine. A simple fistula should be closed by operation as soon as it becomes apparent that, despite every effort to preserve his fluid balance, the patient is becoming dehydrated and is losing ground. Digestion of the abdominal wall may be another indication for operation to close the fistula. Where the fistula is the result of extra-abdominal resection of a loop of small bowel, then, as soon as the Paul's tubes have come out, an enterotome is introduced, preferably under Pentothal

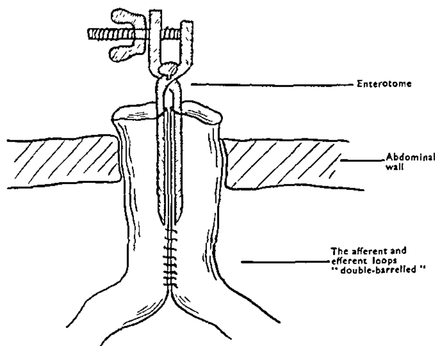


FIG 20.—The enterotome crushing the contiguous walls of the afferent and efferent loops preparatory to closure of the fistula.

anæsthesia, to break down the walls intervening between the two limbs of the gut (Fig. 20). As a routine nowadays surgeons sew these two limbs of the loop together at the original operation so that there is no danger of any other structure, such as another loop of bowel, insinuating itself between them and being liable to damage when the enterotome is closed. If the limbs have been " double barrelled " in this way and an anæsthetic is used for introducing the enterotome, then this can be clamped tightly, and the time taken to break down the wall will be lessened by some days. Otherwise the enterotome is closed sufficiently tightly to take a grip of walls without crushing them and half a turn is taken on the screw each day. As soon as the walls have been crushed,

ceases spontaneously when the patient gets up. I have found in practice that the routine use of gastric suction and an intravenous drip, for forty-eight hours after the closure of a colostomy, has noticeably decreased the incidence of post-operative leakage. The benefit from resting the bowel by intravenous feeding is easy to understand; it is, on the other hand, difficult to see how gastric suction operating so far from the seat of the trouble can help. Nevertheless I am convinced empirically of its value.

On the second day following this operation on or proximal to the transverse colon, an enema is given. This is repeated daily for a week, and after that, if necessary, every other day for a week. If the operation has been on the pelvic colon, a small-volume enema can be given, with the greatest care not to distend that segment of the bowel, on the third day; but if there is any doubt about the security of the suture-line, this should be deferred until the fourth or fifth post-operative day.

II. PERMANENT COLOSTOMY

The operation of colostomy is dreaded by the patient. Doctors and nurses are wont to remark that they would rather be left to die in peace with a carcinoma of the rectum than submit to the stench and incontinent misery of an artificial anus. The lay patient will sometimes refuse to allow an early and curable carcinoma to be removed if it entails the suffering with which rumour has invested this operation. Such an attitude on the part of the profession and the lay public is due to the horrors which attend an improperly controlled colostomy. The ever-present dread that gaseous and fæculent discharge will offend their family and their friends has driven some patients to suicide and has cut off from social intercourse hundreds who, with a little instruction as to how to manage their colostomies, could lead happy, natural and useful lives.

To give a patient a colostomy without instructing him in its correct management is as much a surgical crime as to cut the ulnar nerve in an operation on the elbow-joint. It is responsible for much of the delay in seeking advice, which means all the difference between cure and palliation in cancer of the rectum and is one of the factors which contribute to the poor results of treatment in this condition.

Permanent colostomy is commonly performed either as a palliative measure to forestall or allay obstruction in an irremovable carcinoma of the colon, to relieve the pain and irritation from an irremovable carcinoma of the rectum, or as a preliminary to excision of the rectum and pelvi-rectal junction.

there is often some prolapse of bowel wall and where there is not the same tendency to spontaneous closure as is met with in the small intestine.

Fistulæ of the large intestine are rarely spontaneous except cæcal fistula after appendicectomy and very rarely fistula of the pelvic colon. Such accidental fistulæ usually close spontaneously unless they are associated with obstruction distally, as may be the case in a fistula arising in connection with diverticulitis. If distal obstruction is the reason for failure to close, then either an operation must be undertaken to remove the obstruction or the patient must endure the fistula. The principles adopted to close these openings are the same as those described for the small intestine and, if it is not such an anxious task because there is not the same digestion of the abdominal wall or the same degree of dehydration, it is liable to be a lot more troublesome. The enterotome is applied in the same way in an " open " resection as soon as the Paul's tube has come out of the proximal segment and the clamp has fallen off the distal segment or, in a planned colostomy, as soon as this is no longer required. Again, if the limbs have been " double barrelled " and an anæsthetic is used, the enterotome may be clamped tightly, otherwise it is closed gradually during the course of four or five days. In these cases, however, it is rare for obliteration of the intervening walls to effect a closure. A further operation is nearly always necessary.

After the operation for closure, a drainage tube is always inserted down to the bowel. If this drain is left for too long it will determine the appearance of a fresh fistula. If it is shortened too quickly severe infection of a particularly dangerous type may follow and, if the patient survives this, the whole repair will break down. The drain, which should not pass direct from the bowel to the surface, but which should run for some inches under the subcutaneous tissue before emerging, is shortened by half an inch after twenty-four hours. This serves to remove it from actual contact with the suture-line. After another twenty-four hours it is shortened a further half an inch and the end should now rest just inside the musculo-tendinous abdominal wall, but well away from the possibility of touching the sutured bowel. The drain is subsequently withdrawn according to the amount of discharge and there need be no hurry to remove it from this comparatively innocuous site. Some leakage of bowel contents or of gas is not unusual after the third day, but it is much better that this should take place along the tortuous track of the drain than that it should burst out through the skin immediately over the sutured bowel, and it usually clears up after a few days If a slight leak persists, this often

ceases spontaneously when the patient gets up. I have found in practice that the routine use of gastric suction and an intravenous drip, for forty-eight hours after the closure of a colostomy, has noticeably decreased the incidence of post-operative leakage. The benefit from resting the bowel by intravenous feeding is easy to understand; it is, on the other hand, difficult to see how gastric suction operating so far from the seat of the trouble can help. Nevertheless I am convinced empirically of its value.

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A colostomy may make use of either the transverse or the pelvic colon, according to the circumstances for which it is being performed, and may be either an " end " colostomy or a " side " colostomy. In the "end" colostomy, which is the less common, the bowel is cut across and the proximal segment brought out of the abdomen to discharge its contents, the distal segment being closed and removed together with the rectum and anus. In the more common " side " colostomy a loop of bowel is brought out of the abdomen and an opening made into this through which the discharges take place.

The Spur

In this latter type of colostomy there is a tendency for the bowel contents to pass from the afferent loop into the efferent loop without being voided, and in order to obviate this tendency an obstruction or " spur " is made between the two segments by passing a glass rod through the mesentery of the loop close to the bowel. This glass rod also tends to prevent the retraction of the colostomy into the abdominal cavity. Despite this precaution, and unless by a special technique a bridge of skin is interposed between the two loops, a little fæculent material invariably passes on into the distal segment, but with a well-fashioned spur this is immaterial. The glass rod is kept in for a fortnight and can then be removed. If, however, there is a tendency for the whole colostomy to retract within the abdomen, then the rubber tube which was used to retain the glass rod in place can be made to lie under the spur with the glass rod passing over the colostomy, and this rubber tube can be retained for a further one or two weeks.

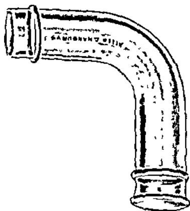
Opening the Colostomy

An " end " colostomy may be prevented from discharging its contents by a clamp which the surgeon leaves on the bowel at the end of the operation and which is included in the patient's dressings. To open such a colostomy it is necessary only to remove the clamp. The tension of gas in the gut itself will be sufficient to separate the walls of the intestine which have been crushed by the clamp and tend to stick together. To open a " side " colostomy it is necessary to cut into the bowel wall. This operation is painless, whatever the method employed, because the nerves of the bowel wall are not sensitive to this kind of stimulus and consequently an anæsthetic is not necessary. The bowel should be cut transversely to its axis two-thirds the way round its circumference, leaving a third of the circumference opposite the mesenteric border held up by the glass rod to form a spur. A transverse cut is to be preferred to one in the long axis of the bowel

because the opening gapes more widely and the vessels run in a transverse direction and fewer are therefore liable to be cut. The operation can be performed with a scalpel or scissors, but is better done by the thermo-cautery which seals the vessels and generally makes the tying of any small bleeders unnecessary.

TIME FOR OPENING

If a colostomy has been performed for acute obstruction, then the surgeon will open this at the time of the operation ; but if it is performed as a palliative operation to relieve the pain and irritation from an irremovable carcinoma of the rectum or as a preliminary to the removal of such a growth, then there is held to be some choice as to when the opening may be made. The purpose of delaying the opening of a colostomy until after the original operation is to allow the cut edges of the abdominal wound to adhere to the extruded bowel before the septic bowel contents are allowed to escape over the field. In this way sepsis, both of the peritoneum around the extruded loop and of the abdominal wall, is to a large extent prevented. There is practically no danger of a general peritonitis, even if the bowel is opened at the time of the original operation, a procedure which, as we have seen, is invariably practised in colostomy performed for acute obstruction. At St. Mark's Hospital only three cases of peritonitis due to sepsis spreading from the colostomy opening were reported in a series of nine hundred and seventy cases, and at this hospital it is the practice to open every colostomy on the operating table at the conclusion of the operation (W. B. Gabriel and O. V. Lloyd-Davies, *Brit. J. Surg.*, 1935, 22, 520). Further, an " end " colostomy with a clamp on constitutes an absolute obstruction, and an unopened " side " colostomy practically a complete obstruction, so that it is unwise to leave the patient too long in this precarious state because, apart from the discomfort and colic caused by the retained gases, the distension of the bowel in these circumstances is a potent cause of paralytic ileus.


FIG. 21 —Paul's tube.

An " end " colostomy should always be opened within twenty-four hours and the contamination may be prevented by tying into the bowel a Paul's *tube*—a flanged glass tube bent at right-angles—attached to a long, soft-walled rubber tube leading to a receptacle under the bed. The end with the double flange (Fig. 21) is

inserted into the colostomy and the space between the flanges is intended to accommodate a retaining purse-string suture. In regard to a side colostomy, there is a difference of opinion as to the ideal time for opening. Some surgeons pay more attention to the prevention of sepsis, others to the prevention of distension. In any case the colostomy must be opened by the third day, and the first or second day after the operation is to be preferred, if the surgeon is unwilling to adopt the St. Mark's Hospital practice and open it at the time of the operation. Contamination of the wound can similarly be prevented by suturing a Paul's tube into the side colostomy.

Dressings and Immediate Management

The dressing of a colostomy is discussed in the previous section (p. 145). The " watershed " strapping prevents contamination of the laparotomy wound, and the Paul's tube, if it has been used, prevents the abdominal wall from becoming soiled. After a few days the Paul's tube will fall out and the method of protecting the part and collecting the discharge in a gutta-percha envelope described in the previous section can be started. The colostomy will probably discharge spontaneously in two or three days, but if by the fourth morning nothing has been evacuated, then a dose of senna should be given and the colostomy washed out with a pint of normal saline. Some authorities advise that the proximal colon should be washed out with a pint of saline each morning, but this tends to the passage of a watery stool incapable of gently dilating the colostomy opening and stricture is more likely to follow than if the plan described below is adopted.

Each day after the fourth a finger is passed into the colostomy to make sure that stenosis is not occurring where the colon comes through the abdominal wall. This practice should be continued daily at the time when the patient takes his bath.

The After-care

Diet and Enema

We now come to the most important and most frequently neglected part of the treatment of the patient, namely, arranging that his colostomy shall open once and if possible only once during the twenty-four hours and for the rest of the day and night shall hold its peace. The preliminary period of this treatment is, as will be appreciated, tedious and entails the patient going on a diet which is uninteresting and to a certain extent lacking in nourishing qualities. Consequently, if the colostomy has been undertaken as a preliminary to some further and

more severe operation, it is wiser to wait until after this has been performed before instituting the regime to be described, spending the interval between the two operations in building up the patient's strength and resistance, and leaving the colostomy to take care of itself, which it will often do with surprising facility. If, however, the colostomy is a palliative one, its " training " can start almost at once.

Three or four days after the final operative procedure the patient will be taking milky foods, bread and butter and possibly a lightly boiled egg. On this diet a colostomy can be relied upon to behave itself. It will probably discharge spontaneously once in the morning and once more during the course of the day. The patient is now given kaolin in sufficient quantities so that the colostomy will not discharge at all unless 4 or 5 ounces of warm olive-oil are run into the proximal segment through a soft rubber catheter which has been well lubricated. The funnel containing the olive-oil should be held eighteen inches above the level of the colostomy. If the olive-oil is ineffective a soap solution (1 pint) can be used, but the routine use of soap solution is not to be encouraged, because it is liable to lead to an irritating mucous colitis. An evacuation will follow this enema in the course of a few minutes and, provided sufficient kaolin has been prescribed, no further evacuation will occur until the process is repeated on the following morning. Some patients, however, find that their colostomies are controlled with greater certainty if they arrange for two evacuations during the day, one in the morning and one in the evening. It is well to spend a little time and trouble in getting the colostomy stabilised at this stage because it is the " base line ", so to speak, upon which all the subsequent treatment is built up.

The patient is now supplied with a note-book, and one (and only one) fresh article of diet is added each day. If this addition upsets his colostomy either by making it work apart from the enema or by the production of offensive gas, then it is put on the left-hand page of the note-book, to be avoided in future. If, however, no disturbance accrues to the colostomy, it is entered on the right-hand page and is added permanently to the patient's dietary. If there is any doubt about the effect, then it should be added to the left-hand page but marked with a query, and can be tried again later on when the colostomy has had more time to " settle down ". In this way and in the course of a few months a patient can build up a variegated and interesting diet of articles which can be guaranteed not to upset his colostomy.

He must be warned that such generic terms as " jam " and " greens " do not constitute " articles of diet ". Cookham's raspberry jam may give him diarrhœa, while Boilem's marmalade may have no

effect. Similarly Brussels-sprouts may produce volumes of offensive gas, whilst spinach is well tolerated. Many patients find that in time they can cut down the kaolin and even dispense with it altogether, except occasionally when, as for instance because of some mild infection, their colostomy becomes temporarily disordered.

Before discharging the patient from hospital or nursing home it is the duty of the doctor to make sure that he understands clearly the nature of the experiment which he has to perform. He should be instructed how to give himself the daily enema, and he should be supplied with a Nitch's or Rose's colostomy horn and a colostomy belt (Fig. 22). Gabriel (*The Principles and Practice of Rectal Surgery*, London, 1937) advises taking Normacol (Norgine) or Isogel (Allen and Hanburys), which produces a stool of satisfactory bulk and soft consistency. Some "colostomy" patients should take Charkaolin (Allen and Hanburys), as it not only produces an easily controlled semi-solid motion, but at the same time frees it from much of its odour.

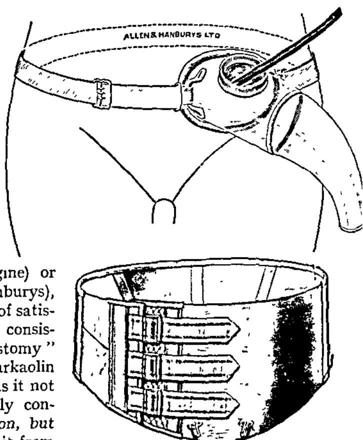


FIG 22 —Colostomy horn and colostomy belt.

The patient's routine will then be as follows. On rising he takes a cup of hot tea and a charcoal biscuit and prepares a warm bath. He then gives himself an olive-oil enema and, seated by the side of the lavatory-pan, directs the discharge into the pan by means of the colostomy horn, which is held with the expanded end placed firmly over the colostomy opening. The colostomy is then cleansed with cotton-wool. The patient takes his bath, passes a finger into the colostomy opening, adjusts the colostomy belt, and need give no further thought to his colostomy for another twenty-four hours, except to give himself a further enema later in the day if he finds his colostomy is

better controlled that way. His diet during the rest of the day will conform to the rules which he has made for himself by the method of trial and error, and he will take that amount of kaolin which he finds necessary and a few charcoal biscuits or some Charkaolin granules suspended in water. If the rectum has been removed, he will once a week wash out the distal segment of the colostomy by running into it half a pint of warm saline and siphoning this back. If the rectum has not been removed, more frequent irrigations of the distal segment with a weak solution of alum are desirable to control the discharge of blood and mucus.

Under such a regime the possession of a colostomy is in the vast majority of cases a disability which is quite inconsiderable. If there is no associated disability, a patient can lead an active social life, play golf and tennis, ride and bathe, and cease to think of himself as an invalid. One patient of a colleague, who had a temporary colostomy for a rare inflammatory condition of the rectum, is so little inconvenienced by this that he is unwilling to undergo another operation to have it closed. In aged, debilitated or foolish patients such a state of affairs cannot be attained. The effective management of a colostomy demands determined and intelligent co-operation. Where this cannot be obtained, and in the case of the aged poor, institutional treatment is usually desirable.

Where a patient is unwilling to put up with the tedium of working out a diet for himself or where he has not been instructed in the first place in the principles of colostomy management and is seen for the first time with his colostomy thoroughly disordered, the following scheme, described by Bargen and Victor and quoted by Gabriel, may be a valuable starting-point for a fuller diet.

Breakfast.—Orange-juice 2 ounces, one rasher of bacon or one egg, toast, butter, coffee, brewer's yeast half a drachm.

Dinner.—Meat (one slice), potato (one or two), shredded lettuce (limited), bread, toast, biscuits, butter, jelly, boiled milk (one glass), tea, brewer's yeast.

Supper.—Cheese 1 ounce, meat (one slice) or two eggs, potato, one banana, bread, toast, biscuits, butter, jelly, boiled milk (one glass), brewer's yeast.

Colostomy Belts

Owing to the inevitable weakness of the abdominal wall and to a less extent in order to control the discharges after a colostomy, the patient will need to wear a belt. Gabriel advises the "Abdo" belt, which is cheap and will last up to a year. The inner surface is covered

with protective material and the colostomy is controlled by placing over it a "cardboard sandwich" made of two layers of cotton-wool with a circular piece of cardboard four inches in diameter interposed between them. At night a gauze dressing covered with a pad of wool is kept in place by a light woollen body-belt. Cups over the colostomy are usually unnecessary and rubber cups are definitely harmful in that they induce suction and lead to prolapse of the colon. A celluloid cup may be worn for special social occasions when it is particularly necessary that no accident should occur and this is kept on by an elastic band round the waist. The routine use of a celluloid cup is, however, unsuitable, as it leads to weakening of the abdominal wall.

Complications

The complications of a colostomy are mainly due to faulty technique at the time of the original operation. *Prolapse* of the proximal segment is due to lax colon on the proximal side of the opening, and is prevented by bringing to the surface the most proximal portion of the bowel which can be extruded from the abdominal cavity without tension. Mild degrees of prolapse are relatively common and do not give rise to any disability nor do they require treatment. For the more severe degrees some form of pressure-pad may control the prolapse and occasionally manual reduction of a swollen œdematous prolapse will be required or an operation will be called for to amputate the prolapsed segment.

Hernia of the whole colostomy may be due to cutting rather than splitting muscle fibres at the time of the operation, so that the abdominal wall adjacent to the colostomy is lax and gives way; to a misplaced colostomy opening; or to the continual use of a rubber or celluloid cup which acts as a suction apparatus. Slight degrees can be controlled by a pressure-pad, but the more severe types may require operation for repair of the abdominal wall.

Spur retraction should not occur if the glass rod or rubber tube is retained sufficiently long. The only treatment for the condition is an operation to make a fresh colostomy.

Stenosis of the skin will not commonly occur if a piece of skin is removed at the time of the operation and not simply incised. It frequently complicates spur retraction and renders the colostomy useless. Mild degrees may be treated by digital dilatations at first daily, then weekly. The more severe degrees will demand reconstructive operation.

Lastly *intestinal obstruction* may occur from strangulation of a loop of small bowel in relation to the colostomy loop. This is a rare com-

plication, and when it occurs is usually due to the passage of a loop of ileum through the space between the colostomy and the lateral wall of the pelvis. The signs and symptoms of acute intestinal strangulation will develop and the condition requires urgent operation.

III. THE RECTUM AND ANUS

Hæmorrhoids, Fissure and Fistula

The after-treatment of minor operations on the rectum or anal canal is much the same whether the operation has been performed for hæmorrhoids, fissure or fistula, and they will therefore be considered together.

The Bowels

It has long been realised that it is impossible to keep the operation field sterile, so that the old-fashioned practice of confining the bowels for many days after these operations to avoid contaminating this field has been abandoned. In fact, this method had the grave drawback that, when eventually a motion was passed, it was so constipated that much pain was caused. Nowadays the patient is given paraffin ℥ i night and morning, starting as soon after the operation as vomiting and nausea allow. This is merely a continuation of the pre-operative course, so that the motion will be well softened and lubricated. Often some paraffin leaks away on the second or third day and a spontaneous motion is passed soon after. If no motion has occurred by the morning of the third day, a gruel enema is given (Appendix I).

Post-operative Pain

After operations in the sensitive region of the anus, pain is commonly severe for the first twenty-four or forty-eight hours. During this period morphia should not be withheld ; it may be prescribed in doses of a sixth to a quarter of a grain as often as required. Much of the pain is due to spasm of the anal sphincter, but the practice sometimes adopted of injecting oily anæsthetic solutions at the operation site is not without danger of abscess formation and cannot be recommended. The rectal tube (*vide infra*) may be a source of pain and can be removed after twenty-four hours.

The Rectal Tube

At the conclusion of an operation for hæmorrhoids, and generally after the operation for fissure or fistula, a rubber tube half an inch in

diameter is smeared with Vaseline or with Decicaine ointment 2 per cent., and is inserted into the rectum. This serves as a flatus tube and, allowing the egress of blood, reveals the presence of severe hæmorrhage should that complication arise (*vide infra*). To control oozing from the raw areas of the ligatured stumps of the hæmorrhoids, three gauze strips are tucked into the anal canal around the tube. To prevent the tube disappearing into the rectum the external portion should be split longitudinally, folded back over each side of the buttock and fixed by the dressing and T bandage (Fig. 23).

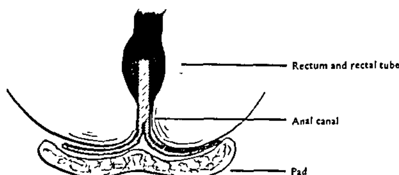


FIG. 23 —The rectal tube split and held in place by a pad.

If causing considerable discomfort, this tube may be removed after twenty-four hours, when it has served its purpose. Care should be taken when removing it to leave the gauze strips in place. The Vaseline or Decicaine ointment round the tube allows this removal to be performed easily. If possible, however, the tube should be retained until the third morning when it provides a ready channel for the administration of the gruel enema. When the enema is returned, tube and dressings together are usually passed into the bed-pan, thus saving the patient much pain. If the gauze strips are not passed, they are allowed to soak out when the patient is given his first bath, which should follow the gruel enema.

THE EXTERNAL WOUND

Because it is impossible to keep the operation field sterile, it is important that free drainage should be maintained, and this is effected by removing a triangular area of skin from the region around the anus. The apex of the triangle points towards the site of the pile, fissure or fistula, and the base lies an inch or more from the anal verge. In fissure, and generally in fistula, only one such Salmon " back-cut " is made, but after operation for hæmorrhoids there are usually three

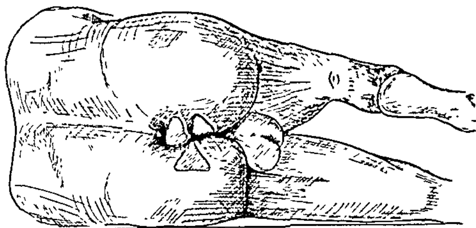


Fig 24.—The Salmon " back-cuts " after an operation for hæmorrhoids. The rectal tube is next inserted and three gauze strips are tucked in round the tube corresponding with the three raw areas.

(Fig. 24). In the hæmorrhoid operation the veins of the underlying external hæmorrhoidal plexus are removed together with the triangle of skin, thus preventing the troublesome post-operative œdema which otherwise follows the operation of hæmorrhoidectomy. These external wounds are sometimes treated with tannic acid, which helps to control bleeding, but usually it is only necessary to place one end of a strip of gauze soaked in Eusol just inside the anus and lay it over the raw area. A dressing is then applied and the whole held firmly by a T bandage. The gauze strips are kept in place until they float off in the first bath, after which they are replaced. After each bath fresh strips are applied and tucked into the anus. Sometimes the gauze strips adhere firmly and will not soak off without a good deal of tugging to effect their dislodgment. This sometimes causes intense pain because the anus, which was everted at the time of the operation, has recovered its tone and has " taken up ", carrying the gauze strips up into the anal cavity. If there is any real difficulty it is justifiable to give the patient intravenous Pentothal for the removal of these strips in the first instance.

Baths and Further Treatment

As soon as possible after the operation, sometimes on the following day and usually by the third, the patient sits in a hip-bath of hot water coloured pink with potassium permanganate. These hip-baths are taken each morning after the bowels have opened and once again during the course of the day. In this way anal spasm is relieved, the raw areas thoroughly cleansed and the Eusol strips readily removed. A ring-cushion placed in the bath enables the patient to move up and

down and swill the solution around the wound. The raw areas epithelialise surprisingly quickly. The patient may get up after a week and can usually be discharged from hospital after ten days to a fortnight, by which time the Eusol strips can be discarded. The slight discharge which comes from the raw areas can be controlled by the use of a dressing kept in place by a T bandage or by a sanitary towel. A soothing application which can be used at this stage of healing is zinc and castor-oil ointment. In three to four weeks the area is usually completely healed. If the Salmon " back-cut " fails to heal, the granulations are touched with silver nitrate and sometimes healing may be accelerated by ultra-violet light. The anal hairs should be cut short as they may become involved in the wound and so delay healing. Too rapid healing or pocketing can be avoided by daily inspection of the area, the judicious use of the silver nitrate stick and occasionally by cutting away overlapping pieces of skin or scar tissue under a local anæsthetic.

Hæmorrhoids

After operations for hæmorrhoids there are special problems to be considered. Hæmorrhage is always a possibility and is usually reactionary, due to a slipped ligature, though secondary hæmorrhage occurs in about 0·5 per cent. of cases. In order that hæmorrhage, if it occurs, shall be revealed, a rectal tube is inserted at the conclusion of the operation (*vide supra*). Generally a tube is used after operation for fissure or fistula, but there is not the same urgent indication for its use in these operations, as hæmorrhage is far less likely to occur. If a " safety-tube " is not employed, or in cases of secondary hæmorrhage after the tube has been removed, the bleeding can only be diagnosed by the general signs of restlessness, pallor, a rising pulse-rate and by a feeling of distension in the rectum creating a desire to go to stool. These signs will not be apparent until an alarming quantity of blood has been lost. Trivial degrees of hæmorrhage will be controlled by the T bandage and by the administration of morphia, but should the bleeding be so severe as to give rise to the symptoms described above, or should considerable amounts of blood escape via the " safety-tube ", then the patient must be taken to the theatre and given a general anæsthetic. The rectum is washed free from blood and clots with half-strength hamamelis solution or other suitable fluid at 115° F. Then, with the aid of a rectal speculum the bleeding point is sought, and if possible secured with hæmostatic forceps. Often the bleeding point has retracted some distance up into the rectum, and it is justifiable in these trying circumstances to seize successively higher portions of

the rectal wall with hæmostatic forceps and draw them down into view. Fortunately, cases of hæmorrhoids frequently have lax rectal walls which readily prolapse, but care must be taken to execute this manœuvre with gentleness, and if there is any resistance, the attempt must be abandoned. If it is not possible to secure the bleeding point, the rectum is tightly packed with gauze and a firm T bandage applied. Lockhart-Mummery employs a rectal tube three-quarters of an inch in diameter, around the terminal three inches of which has been wound a Vaseline-impregnated gauze sponge. This is inserted through the rectal speculum, which is then withdrawn over it. The tube is now pulled on until the encasing sponge is felt to impinge on the anal canal. A large safety-pin is passed through the tube immediately outside the anus and, by inserting dressings between the pin and the anus, pressure is maintained on the anal canal (Fig. 25). Morphia is given, the foot of the bed is raised and a blood transfusion may be deemed necessary. After forty-eight hours the packing may be removed with safety.

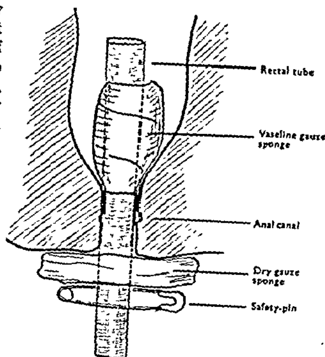


Fig. 25.—Lockhart-Mummery's method of controlling ano-rectal bleeding by pressure between two sponges.

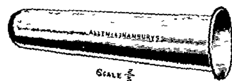


Fig 26.—St. Mark's Hospital dilator.

Stricture

After operation for hæmorrhoids, and to a less extent after those for fissure and fistula, there may be a tendency for a stricture to form. To prevent this the St. Mark's Hospital anal dilator (Fig. 26) should be passed on the fourth day and thereafter daily until healing is complete. In addition a digital examination should

be made a week, and again at a fortnight, after the operation. If a dilator is not available, the anus should be gently distended by the passage of a finger daily after the fourth day.

Retention of Urine

Retention of urine is often a serious problem after these operations and the measures outlined on p. 14 should be tried. If urine has not been voided within eighteen hours a catheter should be passed..

Perineal and Perineo-abdominal Excisions of the Rectum

These operations are attended by a considerable degree of shock and some loss of blood. The patient is returned to his bed in a moderate Trendelenburg position, and this is gradually reduced by unblocking the foot of the bed during the ensuing twenty-four hours. A transfusion of a pint of blood is given as a routine, if possible, by the drip method. For the next three days, and until peristaltic sounds are audible with the stethoscope, fluid is given intravenously, allowing 6 pints in the twenty-four hours. At St. Mark's Hospital all intravenous fluid is given in the form of normal saline on the grounds that the loss of chloride is severe after these operations. But unless a paralytic distension is marked there would seem to be no special indications for these large quantities of chloride, and in the old and debilitated subjects of a rectal cancer there must be a real danger of encouraging pulmonary complications from salt retention. Accordingly it is advised that only half the volume of intravenous fluid should be in the form of normal saline, the remainder being 5 per cent. glucose in distilled water. During this time, only sips of water are given by the mouth. As soon as the drip-apparatus is taken down the volume of fluid taken by the mouth is rapidly increased to 4 ounces an hour and thereafter patients are encouraged to drink freely.

The Indwelling Catheter

An indwelling catheter is inserted, and this, connected to a Cuthbert Dukes' apparatus (p. 174), is maintained for five days, by which time normal micturition will have been re-established. Women should not be exempt from this practice, as any leakage of urine into the perineal wound within the first few days may lead to very severe infection.

Dressing

After forty-eight hours the packing is removed from the perineal wound and the cavity irrigated. For this purpose the patient is turned on to his left side with the buttock well over the edge of the bed. A

mackintosh draw-sheet is placed under the buttock and so draped that it will discharge its contents into a bucket. A 2-pint douche-can is sterilised and filled with Eusol at 105° F. A glass nozzle at the end of a long piece of rubber tubing directs the flow of Eusol from the douche-can at two feet head of pressure into the cavity, which is irrigated in this way until all clots and debris have been washed away. The cavity is then lightly packed with gauze soaked in Eusol. This performance is repeated twice daily until the wound has practically closed. The above method is held to be superior to that of syringing out the cavity, as unrestricted quantities of fluid can be used at constant pressure. If the necessary apparatus is not available, however, a glass or metal aural syringe can be used and the efflux collected as far as possible in a kidney-dish pressed into the buttock. The patient is usually fit to get up in a fortnight to three weeks and is discharged after about four or five weeks with the perineal wound practically healed. A perineal dressing may be retained in place by fastening it to the colostomy belt; and, until healing is complete, lanoline or other suitable unguent prevents the dressing from chafing.

COMPLICATIONS

Hæmorrhage from a perineal wound is rare and is usually due to oozing from the veins of the prostatic or vaginal plexus. It may be readily controlled by general measures and by flushing the wound with a weak solution of potassium permanganate at 115° F.

A persistent fistula in the perineum may be due to:

Retained foreign body.

Retraction of the colostomy spur, allowing fæces to pass on into the distal loop.

A recurrence of carcinoma in the blind end of the distal loop.

Leakage from the blind end which has failed to heal and formed a mucous-lined track.

Osteomyelitis of the sacrum.

If the colostomy spur has sunk in, then an operation will be required to refashion it. A recurrence of carcinoma can usually be detected by the washings from the distal loop (p. 159) becoming blood-stained, and further operative treatment may be considered. In the case of a simple mucous-lined track, Gabriel (*The Principles and Practice of Rectal Surgery*, London, 1937) recommends the passage of a probe on to which silver nitrate has been fused, or the insertion of the nozzle of a Record syringe into the fistula and the injection of 5–10 c.cm. of acriflavine in pure anhydrous glycerine (1 : 1,000) along the track. Osteomyelitis

of the sacrum is rare and usually resolves spontaneously. If a sequestrum forms, as shown by X-ray examination, then it must be removed.

IV. HERNIA

The problem of fluid administration and the care of the bowels in the after-treatment for strangulated hernia have been dealt with when discussing intestinal resection (p. 147). Retention of urine (p. 14), scrotal hæmatoma (p. 198), and wound sepsis (p. 25) are all complications after operation for hernia. The only special problem in the after-treatment of these cases, other than the strangulated variety, is when to allow the patient to get up. Broadly speaking, hernia operations are of two types—an excision of the sac in children and an excision of the sac *together with some form of repair in adults. In children it is not* necessary, nor is it in fact practicable, to keep them in bed for longer than a week. At the end of this time, in the majority of straightforward cases, the patient is jumping about on the bed and would be better employed at the seaside playing on the beach, whither he may be sent at the end of ten days.

" *In adults*, on the other hand, there is the integrity of the plastic repair to be considered. This is not sufficiently strong to allow the patient to get up before three weeks and, although it may be irksome to keep an otherwise fit patient in bed for this length of time, it is a precaution which is amply repaid." The above paragraph has appeared in previous editions of this book and represented my views *at the time. It is still the " official " view, but for the last year,* defying a benevolent authority, I have been getting my Service patients up after repair of an inguinal hernia (by the Scott-Tanner " slide " method) on the fifth day. If the repair does not hold soon after it has been effected it is hardly likely to do so three weeks later and, at least in times of emergency, the loss of " man-hours " by keeping patients in bed for a further fortnight with a correspondingly long convalescence is a heavy price to pay for a doubtful return. In the event I have been delighted with the results of this step ; there is little of that abdominal weakness and protuberance that no amount of " exercises in bed " can altogether prevent, and in nearly a hundred cases there has so far been no recurrence brought to my notice and certainly no early recurrence. I make no claim for this practice, but I feel that opinion should not be allowed to harden in favour of prolonged recumbency without more evidence of its value. After repair of a femoral hernia a fortnight is the limit for an uncomplicated case to be confined to bed. After being up for four or five days

he should go away for a holiday. This holiday must last for a further three weeks at least, so that it is not until four to eight weeks after the original operation that the patient can return to normal life and, even so, manual labour must not be undertaken before three months. Unless his work necessitates it, an adult who has had a plastic repair operation for hernia should never lift heavy weights, roll the lawn or open recalcitrant windows.

A patient who has had a hernia operation should never strain at stool, while coughing, or to pass water. Where there is a tendency to constipation, paraffin should be taken regularly to ensure a soft motion. If the patient anticipates the passage of a difficult motion then, before any straining is attempted, the knees and hips should be flexed fully so that the thighs are in contact with the abdomen. In this position the strain on the inguinal canal is lessened, but if possible such a motion should be retained and the patient should take a dose of salts which will render the subsequent passage an effortless affair. Any chronic cough must be treated by the prescription of a loosening cough-mixture so as to avoid "hacking". The patient should be enjoined when coughing to put one hand in front of his mouth for politeness and one hand in his trouser pocket over the scar for safety. Difficulty in passing water may require that a stricture receives attention. It is unlikely that a man of the "prostatic age" will undergo an operation for the repair of hernia, but prostatic obstruction may occur subsequently and the history of an old hernia operation is a factor in persuading the surgeon to operate on the enlarged prostate.

Where it is necessary that the patient should subsequently engage in strenuous muscular activity, as for instance in Service patients, then, as we have seen, this must not be undertaken until three months have elapsed from the time of the operation. The last weeks of this period can be occupied by doing the special hernia exercises which are contained in Chapter XIV.

The Wearing of a Truss

If, instead of operation, the patient is fitted with a truss, there are a few points which should be considered. In the first place a spring truss is better than a webbing truss as far as control of the rupture is concerned, but a webbing truss is more comfortable. In some elderly men, with arthritis of the lumbo-sacral and sacro-iliac regions, a spring truss may press too hardly on these points and a webbing truss may have to be worn although, before the spring truss is discarded, it would be as well to try a pad of wool over the sacral region where the truss presses and to wear the truss outside the shirt. The perineal

straps supplied with trusses may be uncomfortable and are not necessary if the pad stays accurately in position without them. If the rupture passes into the scrotum, then a "rat-tail" truss is prescribed. A patient is measured for a truss as shown in Fig. 27. The tape starts at the symphysis pubis, is carried to a point midway between the great trochanter and the iliac crest, horizontally round the sacrum to a similar point on the opposite side and back to the symphysis pubis. This measurement in inches is the size of the truss required. In addition the instrument maker will require to know which side the rupture is on or if it is bilateral; whether it is inguinal (direct or indirect), femoral or inguino-scrotal (rat-tail truss required); the size of the swelling when fully prolapsed ("hen's egg", "walnut", etc), and the general bodily build (fat, medium, thin). Satisfactory trusses can be supplied according to such specifications, but it is always wiser to fit a truss in consultation with the instrument maker and the patient, and in certain unusual types of hernia this is imperative. Before putting the truss on, the hernia must be completely reduced and the truss must always be put on in bed before the patient gets up For those who can afford it, a celluloid-covered "bath truss" may be put on in bed, to be replaced by the leather-covered truss when the patient has had his bath, the exchange taking place with the patient lying down In hot weather it may be convenient to wear the celluloid truss throughout the day The skin over the hernia and over the sacrum where the truss makes contact should be dabbed daily with methylated spirit, dried and powdered with talc.

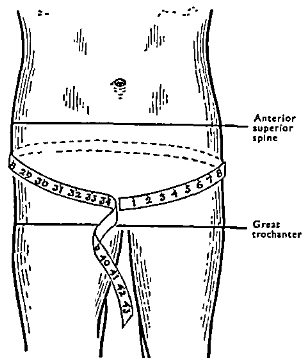


FIG 27 —Measuring a patient for a truss

LARGE HERNIÆ

In the large, irreducible scrotal herniæ of old men operation is contra-indicated because of the age of the patient and often from the

fact that the abdomen simply would not contain the volume of gut which would have to be replaced within it, the hernia having become so large as to constitute an important subsidiary receptacle for the abdominal contents. These patients suffer from *intertrigo* and *eczema* of the skin of the scrotum which is stretched taut over the large hernial sac. Because of the wide neck the danger of strangulation in these herniæ is negligible. The skin is treated first with Ung. Hydrarg. Oxid. Flav. 2 per cent. until the intertrigo has healed, and is then washed carefully twice daily with soap and water and powdered liberally. The scrotum is supported in a mesh-work bag so that perspiration can evaporate. As the contents of the sac often consist to a large extent of fat-laden omentum, the patient is put on a fat-reducing diet which serves to decrease the size of the swelling to the great benefit of the overlying skin and to the considerable comfort of the patient, who now has to support an appendage which is only a fraction of its previous weight.

CHAPTER IX

THE GENITO-URINARY SYSTEM

I. GENERAL CONSIDERATIONS

After operations on the genito-urinary system certain particular considerations apply. Perhaps to a greater degree than elsewhere in the body operations on this system tend to derange its function and it is therefore necessary to have an accurate picture of this function throughout. *This is especially necessary, in that many of the operations are conducted in two or more stages and the times at which these stages are performed depend primarily on the kidney function.*

Attention must therefore be paid to the general condition of the patient in order to detect the earliest signs of uræmia. The mental condition—drowsiness in the day-time and restlessness at night—is significant. The presence of headache, mistiness of vision, a dry coated tongue and uræmic breath should all be noted. In addition the retinæ should be examined for albuminuric retinitis and the blood-pressure recorded. The volume of fluid intake must be charted. The urine must be tested for albumen, blood, sugar, acetone and pus each day, the specific gravity noted, and the volume secreted in every twenty-four hours measured and entered on the patient's chart. If there is leakage into dressings or into the bed, then the volume of this must be computed and added to that measured. Every week or ten days it may be necessary to estimate the blood-urea, to perform a urea-concentration or urea-clearance test and to have the urine examined bacteriologically. If a patient develops the symptoms and signs of uræmia, these should be confirmed by estimating the blood-urea, but it must be remembered that the clinical signs of uræmia may appear without a corresponding rise of blood-urea. If there is obstruction to the urinary flow, this must be overcome by catheterisation or suprapubic cystostomy according to the indications. Fluid should be given in large quantity, and if the patient cannot take between 5 and 6 pints by the mouth in the twenty-four hours, then this must be supplemented by rectal or intravenous infusion. In suppression, the excretory function of the kidneys may be stimulated by the intravenous infusion of a pint or more of 4·2 per cent. sodium sulphate solution, a diuretic which is of particular value in calculus anuria. Hot fomenta-

tions to the loin may stimulate kidney function by increasing the local blood-supply. If there is venous distension, indicative of a heart incapable of coping with the increased blood-pressure, then venesection of 10–15 ounces of blood may be practised. In genito-urinary surgery, if the bladder is being constantly irrigated over long periods, normal saline should be used for this purpose, as it is bland and non-toxic; if the bladder is being washed out once or twice daily by syringing solution in and out through the urethra or through a suprapubic tube, then silver nitrate or mercury oxycyanide may be used in strengths which differ according to the circumstances and which are detailed specifically below.

Calibration of Catheters

Much confusion exists because four different scales are used in numbering the various sizes of catheters and bougies, of which the two types commonly employed in this country are the English and the French (Charrière).

The relation between the four scales is as follows:

French (Charrière).—Sizes range from No. 4 to No. 40. (The numbers denote the external circumferences in millimetres.)

French (Beniqué).—The scale numbering is twice that of the Charrière. (Charrière 20 equals Beniqué 40.)

American —The scale numbering is two-thirds that of the Charrière. (Charrière 30 equals American 20.)

English.—The scale numbering is two points less than the American. (American 14 equals English 12.)

Thus:

Beniqué scale 42
= Charrière scale 21 (circumference in millimetres)
= American scale 14 (two-thirds Charrière)
= English scale 12 (2 less than American).

The Indwelling Catheter

Should an indwelling catheter be required, certain precautions must be adopted to prevent infection from reaching the urethra and bladder. An indwelling catheter is usually uncomfortable for the patient and is a source of danger unless the strictest aseptic precautions are taken in passing it. Before inserting the catheter, the urethra should be washed out with potassium permanganate (1 : 4,000). The maintenance of the catheter demands constant care, otherwise sepsis will appear and

urethritis, epididymitis or prostatitis will render the patient's life intolerable. The end of the penis and the emergent portion of the catheter should be surrounded by a gauze sponge soaked in glycerine which is changed each day. The end of the catheter must never be allowed to hang into a bottle placed between the legs, but it may be occluded by a spigot. The most effective way of preventing sepsis is to connect the catheter to a rubber tube which is led down to a flask

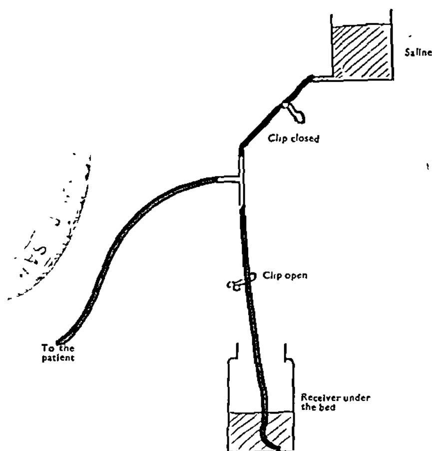


FIG. 28 —Apparatus for intermittent irrigation through an indwelling catheter.

under the bed containing antiseptic solution below the surface of which the end of the tube dips. Alternatively a system similar to that described by Cuthbert Dukes may be employed. The catheter is connected to the stem of a T-shaped glass tube. The upper limb of the T tube connects with a flask containing normal saline suspended above the bed, the lower limb passes to a container under the bed. Both limbs are controlled by clips (Fig. 28). The clip between the T tube and the saline solution is normally closed, the clip between this tube and

the container under the bed is normally open, so that the bladder is kept empty. Every two hours the latter clip is closed and by opening the top clip 2 or 3 ounces of normal saline solution are run into the bladder. The top clip is then tightened and the bottom clip unscrewed, so that the saline drains away.

This method is in some respects to be preferred to that originally

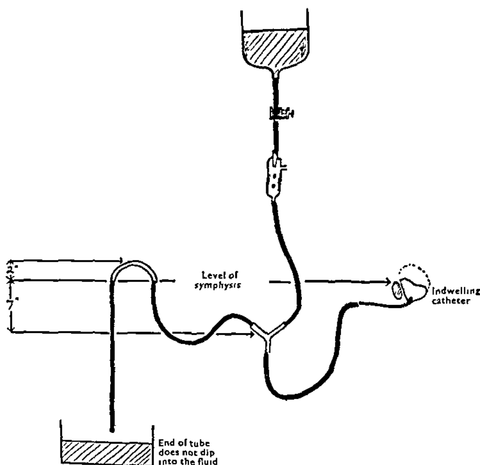


FIG 29.—Tidal drainage.

described by Cuthbert Dukes, in that the pressure in the bladder can never rise beyond a known point (depending on the height of the T tube) and may be kept at zero. In this way reflux of urine up the ureters can be prevented.

In certain cases, especially of spinal-cord lesions, a system of tidal drainage can be used, but this demands a special apparatus and some experience in its management. Essentially, the catheter is connected to the stem of a Y tube, one limb of which passes to a reservoir

containing saline via a drip-feed connection and the other limb to a receptacle under the bed via an inverted U tube (Fig. 29). Saline is allowed to drip into the bladder at the rate of a drop a second. As the bladder fills, the level of the fluid rises in the ∩ tube until the pressure in the bladder is sufficient to drive the fluid to the apex of the ∩. At this point the whole contents of the bladder are siphoned over into the receptacle and the system starts to fill up again.

Methods of Fixation

In women a self-retaining catheter of the de Pezzer type is satisfactory, but in men a gum-elastic catheter will probably have been passed. It is retained by tying a piece of tape firmly to the catheter about two inches from the urethral orifice; the ends of the tape are then

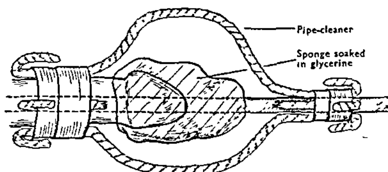


Fig 30.—The "pipe-cleaner" method of retaining an indwelling catheter.

passed over the glycerine sponge to the sides of the penis, to which they are strapped, and here they are turned back and fastened by a fresh piece of strapping. Instead of tapes four pipe-cleaners may be used, and these are strapped to the catheter and to the penis, each making a wide detour, so that a kind of cage is formed around the glycerine sponge. Both ends of the pipe-cleaners are turned back and fresh strapping applied to prevent them pricking (Fig. 30). Foley's self-retaining catheter, as sold in this country by Messrs. Thackray Ltd, is a very satisfactory one (Fig. 31). It is made of 'Latex', a rubber-like material, around the end of which is a distensible bag connected to a narrow-bore tube which runs down inside the catheter. The catheter is passed with the bag empty. As soon as it is in position the bag is distended by injecting 5 c.cm. of fluid down the inner narrow-bore tube which is then occluded by a clip or spigot. On removing the spigot the bag collapses and the catheter may readily be withdrawn.

The indwelling catheter should be regarded as an open surgical wound, equally likely to become infected and often with more serious consequences. The catheter should be changed at least every fourth day.

The tube which connects the catheter to the container (or T tube) should be long and a wide loop is made to allow some freedom of movement in bed without dragging on the tube. It then passes underneath the thigh and is pinned to the mattress, from where it may be allowed to

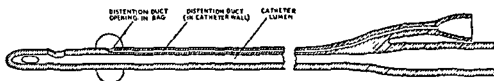


Fig 31 —Foley's self-retaining catheter.

fall into the container. Painful spasm of the bladder sometimes gives rise to trouble. The tube must be examined to see that there is no drag and particularly that it is passing under and not over the thigh, and sedatives may be required. An injection of atropine gr. $\frac{1}{100}$ sometimes brings relief.

Acute Retention

This may be caused by enlargement of the prostate or by stricture of the urethra. It is overcome where possible by conservative measures (p. 14) and, if these fail, by catheterisation or suprapubic cystostomy. In certain cases of stricture it may be possible to pass only a filiform bougie through the stricture, and if this be so, the urine may be allowed to trickle out round the bougie and collect in a flask between the legs. In most cases, however, whether of prostatic or urethral obstruction, a catheter will have been passed.

Methods of Slow Decompression

It is important that the bladder should not be decompressed too rapidly, otherwise the kidneys may cease to function and the patient will become uræmic or hæmorrhage may occur. When the catheter is passed, urine will gush out and 15 ounces may safely be removed at once. The catheter should then be closed with a spigot and some form of gradual decompression of the bladder is adopted. One satisfactory method is to *remove 4–6 ounces of urine each hour*. The kidneys cannot excrete this volume of urine and the bladder is therefore slowly emptied. The disadvantage is that it demands constant and reliable attention day and night. Another method is to attach a soft

rubber tube to the catheter and tie off the end of this tube. *A hypodermic needle* is thrust into the lumen of the rubber tube and through this needle the urine slowly drips away into a container. Alternatively the tube may lead to a *glass drip-connection* if this is available. The volume escaping must be measured and the size of the needle or drip-connection should be adjusted so that about 5 ounces escape each hour. Another check on the rate of evacuation is the height of the bladder in the abdomen and this should be marked. The level of the bladder

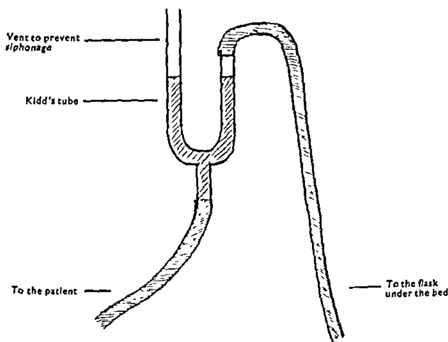


FIG. 32.—Kidd's U tube

This method allows the pressure in the bladder to be very accurately controlled by raising or lowering the tube. If, during the course of decompression, signs of uræmia appear, then the intravesical pressure can be restored by raising the U tube.

should recede about an inch a day. The method described by Kidd, although somewhat complicated, is of particular value in cases where uræmia is anticipated, and has the great advantage that it is so designed as to overcome the difficulties of siphonage (Fig. 32). The catheter is connected by rubber tubing to the stem of the glass U tube. By adjusting the height of the U tube the rate of emptying of the bladder can be controlled. The tube is suspended at such a height that urine overflows only when the patient coughs or makes a muscular effort. It can be lowered each day to an extent depending on the height of the bladder felt through the abdominal wall and on the volume of urine collected. If signs of uræmia appear, then the pressure can readily be

increased by raising the U tube once more. When a Kidd's tube is not available, then in order to prevent siphonage a λ tube with the stem left open may be used instead of the U tube.

SUPRAPUBIC CYSTOSTOMY IN ACUTE RETENTION

In certain cases of retention it may have proved impossible to pass a catheter. Suprapubic cystostomy will then have been performed and a self-retaining catheter secured in the bladder by a purse-string

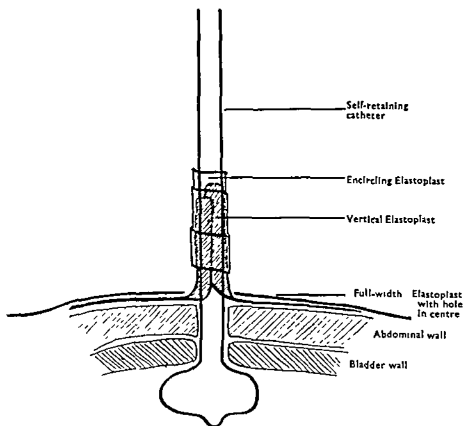


FIG 33 —Method of securing a self-retaining catheter.

suture. Exactly the same principles of slow evacuation can be carried out by [illegible]
dressin[illegible]
tion through the abdominal wall and reliance must be placed on the volume of urine discharged. If a drain has been inserted into the cave of Retzius, this may be removed after four days. Patients with obstruction of such a degree that catheterisation is impossible, and on whom therefore a suprapubic cystostomy is necessary, are often unfortunately just those patients who suffer from the mental effects of

uræmia. In their restlessness and particularly at night, if they are not closely watched, they may in their ramblings decide to pull the whole suprapubic apparatus out in one compelling and magnificent gesture. In order to avoid this, besides the precautions which the surgeon may take (to use a self-retaining catheter through a small puncture wound in the bladder, to secure this with two or three snugly fitting purse-string sutures and to stitch the catheter to the skin), the dressing should also help to make the removal of the tube impossible. I have found the following method, coupled with the measures at the time of the operation detailed above, proof against the most determined patient. A small slit sponge is placed over the suprapubic wound. Four strips of Elastoplast six inches long and one inch wide are then strapped to the skin beyond the dressing, and passing over this are applied firmly around the catheter, being bound to it by a further strip of Elastoplast which passes around them (Fig. 33). A strip of Elastoplast, full width and eight inches long, has a hole cut in the middle of it. The catheter is threaded through this hole and the Elastoplast is then pressed firmly down on to the abdominal wall transversely and holds the whole dressing in place. Elastoplast is better than ordinary strapping for this purpose, as it is more adhesive and conforms more accurately to the irregularities of the dressing.

II. THE KIDNEY

Ruptured Kidney

Rupture of the kidney is usually due to the direct violence of a blow or kick in the loin but occasionally it is caused indirectly in association with a fracture of the eleventh or twelfth rib. There will be shock, pain in the loin and the passage of blood in the urine. There may or may not be a swelling in the loin. The treatment of such a condition is primarily conservative. Shock is dealt with (p. 6), and a specimen of urine is collected. In the majority of cases rest in bed and the exhibition of morphia in the early stages suffice to allow the laceration to heal, and the patient may be allowed up out of bed three days after all traces of blood have disappeared from the urine. It might be thought that the mixture of blood and urine which extravasates into the peri-renal tissues would readily become septic, but this practically never occurs and the pyrexia which usually accompanies the absorption of the extravasated blood must not tempt the doctor into exploring the tender mass under the impression that it is an abscess. Probably the function of the kidney is temporarily so deranged by the laceration that very little if any urine contaminates the extravasated blood.

Each time urine is passed a specimen is collected in a test-tube and put in a rack. The boundaries of any mass are marked on the skin with a skin-pencil and frequent pulse and blood-pressure readings are recorded. The indications for operation on such a case are:

(1) Symptoms and signs of gross hæmorrhage.
(2) Increasing or persistent hæmaturia.
(3) An increasing swelling in the loin.

A description of the technique of the operation is not within the scope of this book, but if the above indications are taken it will be rare for a ruptured kidney to be operated upon with a minor laceration which can be repaired. When an operation is indicated a nephrectomy will usually be necessary.

Nephrectomy

After nephrectomy, if there has been no difficulty with bleeding vessels, the incision may be closed without drainage. Complications following this operation are rare, but shock and the effects of hæmorrhage may have to be controlled immediately after operation. Paralytic ileus rarely occurs after nephrectomy, and hernia through the renal incision is an occasional late complication. If a drain has been used because of an oozing kidney bed, then this can be shortened after forty-eight hours and completely removed after seventy-two hours. If the drain serves to give egress to septic discharges, as after operation for pyonephrosis, then it is shortened in forty-eight hours and gradually removed thereafter as the drainage lessens. After nephrectomy for tuberculosis a persistently discharging fistula may give rise to trouble. This is most often due to failure to remove the whole of an infected ureter together with the kidney, and if the discharge persists and it is known that the ureter was not completely removed at the time of the operation, then a fresh incision must be made to explore the stump of the ureter, which must be removed.

Pyelolithotomy

When the pelvis of the kidney has been opened for stone, it is often left unstitched and a rubber drainage tube inserted down to the opening. Provided the ureter has been explored by means of a ureteric catheter at the time of the operation and is found to be unobstructed, urine will only leak along the drainage tube for two or three days and the tube may then be removed. When the ureter has been explored for a stone there is no need to repair the defect in the ureteric wall,

but a drainage tube is left down to the site of the opening in the wall, and if the ureter has been shown to be unobstructed, the leakage of urine very soon stops and the drain can be dispensed with. Some surgeons insert stitches into the pelvis of the kidney or into the ureter after opening them, but this is not necessary. Renal failure should never occur after operation on one kidney, because the function of both kidneys will have been investigated beforehand and no operation is undertaken unless the contralateral kidney can be relied upon. Very occasionally a temporary derangement in the function of the other kidney may follow such operations and is said to be due to a "reno-renal reflex". Fluids are prescribed plentifully, and hot fomentations to the opposite loin excite the kidney to resume its function. Intravenous infusion of a pint or more of sodium sulphate solution (4·2 per cent.) is a most valuable diuretic in such cases.

Nephrostomy

This operation is designed to drain an obstructed kidney. There are two main indications : (*a*) when the kidney is infected and the pus-laden urine is not draining away freely down the ureter, and (*b*) when, after destructive disease of the other kidney, the remaining good kidney becomes obstructed by a stone or other cause and it is necessary to secure a secretory path for the urine before the operation for removal of the obstruction is undertaken. In the first case the kidney is treated as an abscess cavity The tube draining this cavity is turned every twenty-four hours after the first forty-eight, but is not withdrawn until the urinary discharges become clear. In many cases the subsidence of the infection will determine free drainage down the ureter once more, when the tube can be dispensed with and the wound allowed to close. If the kidney has been practically destroyed by the infective process, then secondary nephrectomy may have to be considered. In these heavily infected cases, the amount of the discharge will not be great, because the kidney will probably have been largely destroyed and there is very little if any secretion of urine. A pad of cotton-wool or sphagnum moss wrapped in gauze over the dressing should be sufficient to contain the pus.

In the case of obstruction by a stone in a solitary functioning kidney there will not as a rule be a heavily infected urine, and it may be possible to secure a water-tight junction for the nephrostomy tube by using a self-retaining catheter thrust through the cortex of the kidney into the pelvis. The catheter is then connected to a rubber tube leading to a bottle under the bed. The nephrostomy tube is kept in for at least a week after the operation for removal of the obstruction in the ureter,

by which time the œdema will have settled and drainage of urine by the natural path can be relied upon.

III. CLOSED CYSTOTOMY

This operation is rarely performed nowadays, it being held that if the bladder has been opened it should be drained, but it may occasionally be used for the removal of a stone which is too large or too hard to be broken up and washed away through the urethra. The bladder, which may be closed after such a procedure only when there is no hæmorrhage or sepsis, must be drained by means of an indwelling catheter, and the cave of Retzius is drained suprapubically. The problem of the indwelling catheter is discussed above, and it may be emphasised once more that every care must be taken to avoid infection reaching the point of entry of the catheter into the urethra. A glycerine-soaked sponge should be wrapped round the end of the penis and the emergent portion of the catheter, and the catheter should be changed every third or fourth day. After a closed cystotomy the catheter is retained for a week (being changed after three days) and drains into a bottle containing antiseptic solution under the bed. The drain in the cave of Retzius is removed on the fourth day. The bladder should not be washed out for fear that distension may weaken the suture-line and fluid leak out thereby. If the catheter becomes blocked, an ounce of potassium permanganate solution (1 : 4,000) syringed through will serve to clear it. If bleeding occurs other than to a trivial degree, clots will form in the bladder and the urethral catheter will continually become blocked and eventually cease to function. In this case the suprapubic wound must be re-opened, the clots evacuated and a large suprapubic tube inserted. If bleeding is still taking place, the urethral catheter may be retained and the bladder may be irrigated by the continuous-drip method (*vide infra*).

IV. SUPRAPUBIC CYSTOSTOMY

After most suprapubic operations the bladder is drained suprapubically. This is perhaps always the safest course and is a preliminary to prostatectomy if this is done in two stages. The suprapubic cystostomy may be temporary or permanent. A temporary suprapubic cystostomy comprises the *first stage* of a two-stage prostatectomy, and it is then practised either for renal failure or for sepsis.

For Renal Failure

If the indication for a two-stage operation is renal failure, then the preliminary cystostomy need consist only in the introduction of a self-retaining catheter through a stab wound in the bladder. The urine is led away into a flask under the bed and the patient is given copious fluids to drink. The same precautions are taken to ensure that the self-retaining catheter is not forcibly removed from the bladder as was described above, and the volume of fluid intake and output is carefully measured. The bladder is washed out with mercury oxycyanide (1 : 5,000) or normal saline twice a day. A blood-urea estimation should be done at the end of a week and again at the end of a fortnight, by which time in most cases the patient will be fit for prostatectomy as indicated by a good volume of urinary output—about 80 ounces in the twenty-four hours—and a blood-urea in the region of 40–60 mg. per cent., a urea-concentration test of 2·5 per cent. and a urea-clearance value of at least 60 per cent. of normal. Sometimes suprapubic drainage will have to be carried on for longer periods and exceptionally a permanent suprapubic drainage will have to be adopted.

For Sepsis and Hæmorrhage

If the preliminary cystostomy is performed because of sepsis, then it will be necessary to insert a wide-bore tube into the bladder; the cave of Retzius will have been drained and an indwelling catheter may have been tied into the urethra so that continued irrigation of the bladder can be carried out through this. If the cystostomy follows an operation on the bladder other than as a preliminary to prostatectomy, then the same after-treatment is required as is to be described for the first stage of a prostatectomy in regard to management of the suprapubic wound. Continuous irrigation of the bladder will be necessary only if and while hæmorrhage is troublesome or if the operation has been performed on a septic bladder. In other cases the bladder can be washed out twice daily. Hæmorrhage immediately after the operation is controlled by washing out the bladder through the indwelling catheter, or if that has not been inserted, in and out through the suprapubic tube with silver nitrate solution (1 : 3,000) at 118° F The drain in the cave of Retzius may be removed after four days and the usual precautions are taken in regard to the indwelling catheter if one has been inserted (*vide supra*). The particular problems of this operation are the care of the suprapubic wound and the irrigation.

CARE OF THE SUPRAPUBIC WOUND

It is extremely difficult in these cases to keep the suprapubic wound absolutely dry, but every attempt should be made to do so. At first the tube inserted into the bladder probably constitutes a water-tight junction, and it should be of such a length that it can be joined by a glass connection to a tube leading to a container under the bed and the patient will be kept adequately dry. Paul's soft colostomy tubing is sometimes recommended for this purpose. If this is used, it should be lubricated occasionally with olive-oil to prevent the walls sticking together. Later, when leakage occurs round the tube, other means will have to be adopted. There are three methods commonly employed.

(1) *Sprengel's Pump*

Perhaps the most satisfactory way, if the operation is the first stage of a prostatectomy, is to insert into the wide-bore suprapubic tube a

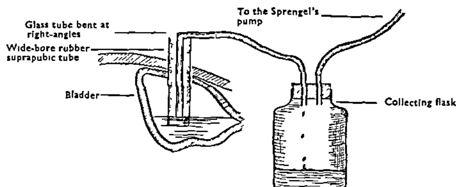


FIG 34 —Drainage of a suprapubic wound by means of a Sprengel's pump.

glass tube bent at right-angles. The limb of the glass tube inserted into the bladder should be slightly shorter than the rubber tube, so that the glass does not impinge on the bladder mucous membrane (Fig. 34). The other limb is led to a Sprengel's pump by means of a rubber connection. Between the glass tube and the pump a container is inserted in which the urine and washings collect. These can be measured and, since the volume of solution washed through the bladder is known, the volume of urine excreted can be calculated. In this way the urine is constantly sucked out of the bladder.

(2) *The Hamilton Irving Box*

This method, sanctioned by long usage, is of universal applicability, but is attended by certain disadvantages. The apparatus is uncomfortable to wear and the tissues are apt to become soggy and prolapse into the box; further, it cannot be fitted with any degree of comfort until the wound has healed and the stitches are out on the seventh or eighth day. As the success of the apparatus depends on it being clamped firmly to the abdominal wall, it is unsuitable though not impossible to apply it earlier. Fortunately, as mentioned above, at least for about the first week after a suprapubic cystostomy the suprapubic tube is usually firmly encompassed by the bladder wall and very little leakage occurs around it.

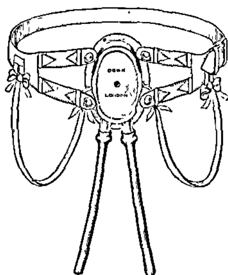


FIG 35.—Hamilton Irving box.

The Hamilton Irving box, which can be made of metal or celluloid, is shaped like a cake of soap. Metal is better than celluloid because it can be boiled and is more durable. The box has a flange which is applied to the abdominal wall and a lid (Fig. 35). It is strapped to the abdominal wall with its long axis vertical by means of a rubber band passing round the upper part of the buttock and is prevented from riding upwards by means of perineal straps. Two outlet tubes lead away from the box and can be connected to a flask between the patient's legs, or preferably to a receptacle under the bed. The success of the apparatus depends upon the close application of the flange to the abdominal wall, which should constitute a water-tight junction. Vaseline or zinc and castor-oil ointment smeared liberally on the skin before the box is applied may help to keep the joint water-tight, but no dressing should be interposed between the box and the skin, unless the suprapubic incision is so long that the wound crosses under the flanged edge of the box. In this case a little gauze soaked in Vaseline must be used to protect the wound, and being at the upper end of the box does not usually constitute a serious source of leakage. For very fat patients with protuberant bellies a better fit may be obtained by using a box with the long axis transverse. A small gauze bag containing boracic crystals is placed inside the box and this is renewed twice daily.

(3) *The Gutta-percha Envelope*

If neither a Sprengel's pump nor a Hamilton Irving box is available when the suprapubic tube ceases to be water-tight, and when therefore drainage is no longer satisfactory by connecting this directly to a receiving flask under the bed, the patient can be kept moderately dry by means of cotton-wool or sphagnum moss wrapped in gauze. A piece of gutta-percha tissue a foot square has a hole cut in the middle of such a size (an inch to an inch and a half) as to surround the suprapubic opening. This is then fastened to the abdominal wall for an inch or so immediately around the suprapubic wound by means of collodion, and a bulk of fluffed-out cotton-wool or moss is placed on top. The free sides of the gutta-percha tissue are now taken up and folded neatly and firmly over the wool or moss. As soon as this becomes soaked, the envelope of gutta-percha tissue is unfolded, fresh wool or moss applied and the gutta-percha tissue once more folded over. This method may be adopted if the patient requires a rest from the Hamilton Irving box because the tissues are being drawn up into the box, and it is becoming painful or irritating.

IRRIGATION

In cases with a septic bladder and where there has been much hæmorrhage as well as in prostatectomy cases, continuous irrigation is practised; in other cases irrigation twice daily is sufficient. For continuous irrigation an indwelling catheter may have been placed *in situ* at the time of the operation, and this is joined by means of a glass drip-connection to a container suspended three feet above the level of the bladder. This container holds a solution of normal saline and the connection is adjusted so that a rapid drip flows through the indwelling catheter into the bladder and out into the Hamilton Irving box, or into the container of a Sprengel's pump system.

If an indwelling catheter has not been used—and many surgeons object to this practice on the grounds that it is unnecessary and intensely irritating to the patient—then continuous irrigation can be carried out entirely through the suprapubic tube. The same flushing system is put up, but it is connected to a narrow-bore rubber catheter which is inserted through the wide-bore suprapubic tube and reaches to the base of the bladder. Irrigation is then carried out at the same rate as before, and the irrigating fluid wells up with the urine and is discharged via the suprapubic drain into the Hamilton Irving box or is sucked away by the Sprengel's pump. In the absence of an indwelling catheter, if the gutta-percha envelope method is being used, or at first

when there is a water-tight suprapubic tube leading to a container under the bed, then intermittent irrigation will have to be practised every four hours. If the suprapubic tube is joined by means of a glass

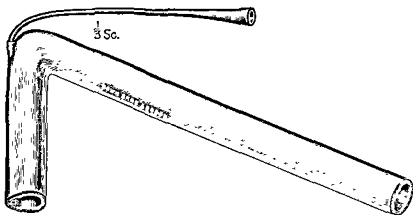


FIG. 36.—Wells' suprapubic tube.

connection to a rubber tube leading to a flask under the bed, this connection is dismantled and 3 or 4 ounces of warm saline are syringed in and out of the suprapubic tube until the washings are clear.

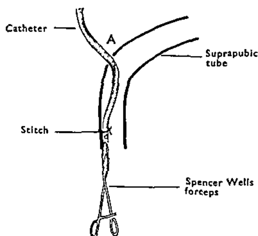


FIG 37.—A home-made Wells' suprapubic tube

A means of providing continuous irrigation with a water-tight suprapubic tube and in the absence of an indwelling catheter is provided by Wells' suprapubic tube (Fig. 36), which includes a narrow-bore irrigation tube. Such an apparatus can readily be made with a rubber catheter, *size 10 (Charrière) and a piece* of wide-bore rubber tubing. A small slit is made in the wide-bore tube at A (Fig. 37), Spencer Wells forceps are thrust through this slit from the inside and, gripping the end of the rubber catheter, pull this through the slit so that the end reaches nearly to the end of the wide-bore tube. The catheter is then held in place by a salmon-gut stitch tied so that the knots are within the lumen of the wide-bore tube. With this method the irrigation tube is joined by means of a drip-connection to a container suspended above the

bed and the washings escape via the suprapubic tube and are collected together with the urine in a flask under the bed.

Irrigation is kept up throughout the twenty-four hours until the patient's temperature and pulse-rate have come down to normal and the urine is uninfected. If after two or three weeks the urine is still grossly infected, then the infection may come from an undetected pyelonephritis or diverticulum of the bladder and the patient should be investigated from this point of view. Usually after a fortnight to three weeks the infection is overcome and the patient will be ready for the second stage of the prostatectomy or, if the cystostomy follows some other intravesical operation, the tube may be removed and the bladder allowed to close.

Permanent Cystostomy

In carcinoma of the prostate and in certain cases of benign prostatic enlargement where the kidney function obstinately fails to recover despite suprapubic drainage, a permanent suprapubic cystostomy may have to be adopted. If, because of sepsis or for other reasons, there has been a suprapubic cystostomy performed previously with a wide-bore rubber tube, then this tube is removed and replaced by successively smaller tubes until the opening is sufficiently small to fit snugly round a self-retaining catheter of the de Pezzer type, size 34 (Charrière), which is inserted by stretching the end tightly over a metal stylet. If the operation has not been preceded by suprapubic cystostomy, a de [illegible]

[illegible] down to the bladder alongside the catheter. This gauze serves to drain the cave of Retzius, but, as gradual decompression of the bladder is not necessary in this case, the rapidly contracting organ grips the catheter firmly, and very little if any leakage occurs, so that the gauze wick can usually be withdrawn in forty-eight hours.

The catheter is occluded by a spigot or a gate-clip. After a few days the catheter is held firmly in position by its expanded end. The only dressing required is a small square of gauze, slit so as to enclose the catheter and smeared with boracic ointment. A flannel belt with a hole through which the catheter is threaded and with a pocket to contain the end of the catheter is worn, and the patient is instructed to evacuate the bladder every three or four hours or more frequently if he feels it to become distended. Leakage around the tube is usually trivial, but if this is in any way troublesome a piece of jaconet, slit to enclose the catheter, is worn next to the skin and rendered adherent to

it with zinc and castor-oil ointment. On top of the jaconet is a layer of cellulose, and then a rubber flange, fixed to the suprapubic tube, which is held closely applied by the belt (Fig. 38). If the patient cannot be relied upon to evacuate his bladder every four hours, then the catheter may be connected to a rubber bladder which is worn suspended from a belt and lies inside the trouser leg. Once each month the catheter is removed by stretching the expanded end over the metal stylet and carefully withdrawing it. *A fresh catheter should be introduced at once* in order to avoid contraction of the orifice.

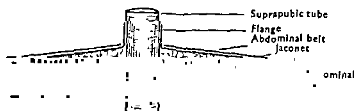


FIG 38.—Dressing for a permanent suprapubic tube. The abdominal wall is covered successively by:
(1) Jaconet (dotted)
(2) Cellulose or fluffed-out cotton-wool.
(3) Flange of the suprapubic tube (red).
(4) The abdominal belt (black).

V. THE PROSTATE

Freyer's and Thomson Walker's methods of suprapubic prostatectomy are performed in one or two stages depending upon the strength of the patient and his kidneys. The after-treatment is essentially that of the cystostomy and the same problems of drainage and irrigation obtain. Here too some surgeons leave a catheter in the urethra and others dispense with it.

Immediately after the operation the suprapubic tube may be connected directly to a flask under the bed. If a catheter has been left in the urethra, continuous irrigation may be practised through this. *If no catheter has been left in, continuous irrigation may be carried out through the suprapubic tube, the overflow being removed by means* of a Sprengel's pump, or intermittent irrigation can be used until such time as a Hamilton Irving box can be fitted and continuous irrigation substituted The Hamilton Irving box should be applied as soon as possible and some authorities advise its use when the patient comes round from the anæsthetic. As was pointed out above, the necessary pressure may be very uncomfortable over a recent wound and as at this stage there are other effective measures of keeping the patient dry and at the same time irrigating the bladder, *it is probably better to wait* for a week before adopting this device.

The drain in the cave of Retzius may be removed on the fourth day,

and on the seventh day the suprapubic tube, which by this time has become loose and around which leakage is beginning to occur, can be taken out and the Hamilton Irving box applied. If a catheter has been left in the urethra it should be retained for twelve days. Irrigation of the bladder can be kept up by means of a narrow-bore rubber catheter inserted through the suprapubic opening, and should only be stopped when this opening is so small that it embraces the catheter. An aperient should be given on the evening of the third day, but enemata should be avoided if possible, as up till the fourth or fifth day they tend to promote bleeding. On about the twelfth day urine is often passed per urethram, usually when the patient is getting his bowels open. Later the quantity increases, and it is passed apart from the act of defæcation. If there is delay in the healing of the suprapubic wound the urethral catheter may be replaced. As soon as the suprapubic wound has remained dry for three days the patient is allowed to get up. The passage of urine by the urethra in the first week is paradoxically a bad sign and these cases rarely do well.

COMPLICATIONS

Hæmorrhage is a common complication of prostatectomy. Morphia should be given and a transfusion may be required after the bleeding has been controlled. A drip transfusion is to be preferred, and in any case the blood must be given slowly so as to avoid raising the blood-pressure and initiating fresh bleeding. Washing out the bladder with silver nitrate (1 : 3,000) at 118° F. should be followed by continual irrigation with normal saline by the drip method. If these methods fail to control the hæmorrhage the suprapubic wound must be reopened and the prostatic cavity packed. If there is not already one *in situ*, a catheter is passed per urethram. With the forefinger as a guide, a strip of gauze is packed tightly with long forceps into the prostatic cavity around the catheter. The end of the gauze is then brought out through the suprapubic opening and the large suprapubic drain is replaced. If bleeding has been severe at the time of the operation the patient may leave the theatre with the prostatic cavity packed in this way. After seventy-two hours the patient is given an anæsthetic of Pentothal or gas and oxygen. The urethral catheter is withdrawn about an inch so that the eye lies opposite the internal urethral orifice and silver nitrate solution or hydrogen peroxide is run in. This serves to loosen the packing, which is then withdrawn. Continuous irrigation is given through the urethral catheter or, if this is removed, suprapubically. Some surgeons advise the use of a Pilcher's bag to control hæmorrhage, but the method is not

without its disadvantages and may cause incontinence; further, it fails to control the bleeding from a large prostatic cavity.

Shock is treated on the lines detailed above (p. 6). *Uræmia* should not complicate the operation of prostatectomy if precautions have been taken to see that the kidneys are functioning adequately before the prostate is removed. Its treatment is outlined on p. 172. *Ascending pyelonephritis* may be responsible for continued pyrexia and progressive renal failure. Fluids must be given freely but the prognosis is very poor.

As a routine nowadays most surgeons ligature both vasa deferentia before removing the prostate. If this is not done *epididymitis* may occur and it is a most troublesome and painful complication. The scrotum should be supported by a sling (p. 199) and the application of Antiphlogistine poultices, while not encouraging suppuration, gives comfort and promotes resolution. If there is any fear that suppuration may be promoted by such an application, then lead and opium compresses may be used instead and an ice-bag placed against the supported scrotum. If an abscess forms it may have to be drained, but this occurs only in a very small percentage of cases.

Prostatectomy does not impair *sexual desire* in the majority of cases. In the nature of things the age of these patients makes it unlikely that sexual vigour will remain long unimpaired, and in a small proportion its loss is dated from the time of the operation. Ejaculation does not occur after prostatectomy, as the semen is excreted into the bladder and is voided with the urine. These patients are therefore sterile if not impotent.

A *recurrence of obstruction* to the urinary outflow after prostatectomy is evidenced by failure of the suprapubic fistula to close, by a return of frequency or by difficulty in micturition. The residual urine accumulates and the whole picture of prostatic obstruction, apart from the psychological symptoms of prostatism, returns. This relatively rare complication is due either to a fibrous stricture developing at the site of the prostatic bed or to neoplasm. An attempt should be made to dilate the stricture with metal bougies and often the patient can be kept quite comfortable and free from symptoms by passing a bougie at intervals of a few months. If, however, the stricture will not admit a bougie size 8/12 French (Charrière), which must be used with the greatest care, or if it contracts down rapidly after the bougie has been passed, then a further operation must be contemplated upon the bladder neck. This need not imply another suprapubic operation, and the bladder-neck obstruction may be quite readily dealt with through the urethra.

The Harris Prostatectomy

The operation which goes by this name consists essentially in a plastic repair to the prostatic bed after the prostate has been removed. As a result of this repair hæmorrhage is controlled and, as there is no large raw area left behind, sepsis is lessened. For these reasons the bladder may be closed after a Harris prostatectomy, although this is not the essential feature of the operation, and if there is any doubt about hæmorrhage or sepsis, then a suprapubic drain is left in. If the bladder has been closed, then before the patient leaves the theatre a few ounces of silver nitrate solution (1 : 3,000) are syringed in and out through the urethral catheter to make sure that this is not blocked and to remove small clots which will, by this time, have collected. After leaving the theatre the catheter is connected to a container under the bed. Usually the urethral drainage will be unimpeded, but if any doubts are felt on this score, then 2 oz. of silver nitrate solution (1:3,000) may be washed in and out of the bladder by means of a syringe. Irrigation is then repeated as often as necessary to keep the catheter free from obstruction.

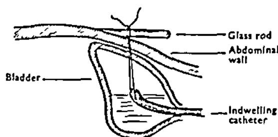


Fig. 39.—Method of retaining the indwelling catheter in the Harris prostatectomy.

The indwelling catheter in this operation is secured in place by a stitch passing through the intravesical end of the catheter and out through the suprapubic wound where it is attached to a glass rod. No further retention apparatus is necessary, so that the penis is free from strapping, but a glycerine-soaked sponge should still be used round the end of the glans, and the catheter is connected to a tube leading to a small Winchester bottle containing antiseptic solution under the bed, so that a closed drainage system is obtained. On the tenth day when the catheter is removed the retaining suture is cut across immediately below the glass rod and the catheter withdrawn, together with the part of the suture passing through the head (Fig. 39). The following day the patient may be allowed up. If hæmorrhage is persistent, despite the adoption of general measures to control it, the bladder must be reopened and suprapubic drainage instituted. In the introduction of the trigonal stitch, the rectal wall may be pierced or damaged. *Pelvic cellulitis* is a possible consequence and, should this appear, conservative measures are adopted until localisation is well

without its disadvantages and may cause incontinence; further, it fails to control the bleeding from a large prostatic cavity.

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Prostatectomy does not impair *sexual desire* in the majority of cases. In the nature of things the age of these patients makes it unlikely that sexual vigour will remain long unimpaired, and in a small proportion its loss is dated from the time of the operation. Ejaculation does not occur after prostatectomy, as the semen is excreted into the bladder and is voided with the urine. These patients are therefore sterile if not impotent.

A *recurrence of obstruction* to the urinary outflow after prostatectomy is evidenced by failure of the suprapubic fistula to close, by a return of frequency or by difficulty in micturition. The residual urine accumulates and the whole picture of prostatic obstruction, apart from the psychological symptoms of prostatism, returns. This relatively rare complication is due either to a fibrous stricture developing at the site of the prostatic bed or to neoplasm. An attempt should be made to dilate the stricture with metal bougies and often the patient can be kept quite comfortable and free from symptoms by passing a bougie at intervals of a few months. If, however, the stricture will not admit a bougie size 8/12 French (Charrière), which must be used with the greatest care, or if it contracts down rapidly after the bougie has been passed, then a further operation must be contemplated upon the bladder neck. This need not imply another suprapubic operation, and the bladder-neck obstruction may be quite readily dealt with through the urethra.

of a Bigelow's evacuator and sucking out the clots by means of a syringe. When the bladder is emptied of clot it is irrigated with hot silver nitrate solution (1 : 10,000) and the inlying catheter replaced. Loughnane passes a two-way catheter as a routine and irrigates the bladder continuously with sodium citrate solution 3 per cent. for the three days in which it is retained. If these methods do not suffice, then the bladder must be opened and the bladder neck packed with gauze as described above (p. 191). The use of a Pilcher's bag or Foley's catheter would seem to be open to less objection and likely to be more effective here than when following suprapubic prostatectomy cases. *Extravasation of urine* is a complication practically confined to perurethral resection. It may be due to cutting too deeply at the time of the operation or to the sloughing of the bladder wall later. The perineum, scrotum and penis and later the abdominal wall become swollen and apparently œdematous. The treatment is operative and demands incision into the perineum and penis and splitting of the scrotum into two halves by an incision which passes readily down the distended median commissure. Suprapubic cystostomy is performed, but the prognosis of this complication is very poor.

Epididymitis, uræmia and *stricture* may complicate perurethral resection and these have been dealt with above. Recto-urethral fistula has been reported following this operation.

VI. BLADDER GROWTHS

Cystoscopic Diathermy

Most papillomata of the bladder are cauterised by electro-coagulation through an operating cystoscope. After this operation the patient is left unencumbered by indwelling catheter or suprapubic cystostomy. This freedom carries with it certain anxieties which must be allayed as far as possible by general treatment. In the first place the patient should not go far away into the country for at least ten days after the fulguration, by which time the dangers of primary and secondary hæmorrhage will be passed. Infection is resisted by instructing the patient to take copious draughts of fluid. In addition some surgeons leave 4 ounces of silver nitrate solution (1 . 3,000) in the bladder for two hours after the operation, when it is drawn off by a catheter.

Should hæmorrhage occur, the patient must go to bed, morphia is prescribed and the bladder washed out with silver nitrate solution (1 . 3,000) at 118° F., using 4 ounces of solution at a time. Rarely, if

advanced, when abscesses should be drained. A rare complication peculiar to the Harris operation is *bilateral hydronephrosis*. This is due to distortion of the ureteric orifices in pulling down the trigonal flap so that they become partly obstructed. This complication is a difficult one to treat and may require a further operation on the ureters.

Perurethral Resection

At the time of the operation a urethral catheter is passed into the bladder, being kept in place by strapping it to the penis, and it is allowed to remain for three days. Irrigation with silver nitrate solution (1 : 10,000) or mercury oxycyanide (1 : 5,000), using 4 ounces at a time, should be carried out four-hourly or more frequently if necessary, to wash away clot and debris and to ensure that the lumen of the catheter is free. The catheter is, as usual, connected to a tube leading to a Winchester bottle containing antiseptic solution under the bed. This bottle should be sufficiently small to be carried about by the patient when he gets up, which he does generally on the day after the operation. The catheter is removed on the third day, by which time urination is usually satisfactory.

Six hours after the catheter has been removed, the patient is asked to pass water and the residual urine is then drawn off. If this is more than two or three ounces, the catheter is tied in once more and left for another three days. At the end of this time, if urination is still unsatisfactory and there is more than a trivial amount of residual urine, more prostatic tissue may have to be removed.

Generally at the end of a week from the time of the operation there is very little difficulty in passing a fair stream and the residual urine is inconsiderable. The patient may then be discharged to his home. Urination may be a little hesitant at first because of œdema, and the full benefits of removing the obstruction are not usually felt for some weeks after the operation, when all reaction has settled. If a suprapubic cystostomy has been performed previously, this may be retained until the urethral catheter is removed on the third day. The suprapubic tube can then be clamped off and the urethral function tested ; as soon as this is adequate the suprapubic tube is removed and the wound allowed to close. Should urination not be practically normal at the end of a month a further perurethral operation may be required.

Complications

Hæmorrhage may be controlled by irrigating the bladder with silver nitrate solution (1 : 3,000) at 118° F. Macalpine (*Cystoscopy and Urography*, London, 1936) recommends passing the thin-walled catheter

A *high fever*, often coming on after the urethral catheter has been removed, may complicate this operation. The urethra should be washed out if this is not already being done, and if the temperature fails to abate the catheter should once more be passed and the bladder washed out four-hourly with silver nitrate solution (1 : 10,000), or mercury oxycyanide (1 : 5,000), until the urine is no longer infected and the acute phase of the pyrexia is overcome.

External Urethrotomy

The Syme or Wheelhouse Operation

After either of these operations the bladder may be drained by an indwelling catheter or by means of a tube passing out through the perineal wound. For the first four days while the tube is *in situ* the bladder is irrigated twice daily with silver nitrate solution (1 : 10,000) or mercury oxycyanide (1 : 5,000). When on the fourth day the tube is removed, the perineal wound is similarly irrigated under pressure from a douche-can. At this time the patient commences twice daily hot hip-baths to which potassium permanganate crystals have been added to colour the water pink. A bougie is passed on the fourteenth day and subsequent treatment with the bougie is the same as after internal urethrotomy (*vide supra*). The acid sodium phosphate mixture is prescribed for a month after the operation.

Excision of Stricture

After excision of a stricture suprapubic drainage is necessary for a fortnight to divert the urinary stream, because the presence of an indwelling catheter would jeopardise healing at the site of urethral repair. The urethra is gently irrigated twice daily with silver nitrate solution (1 : 10,000), or mercury oxycyanide (1 : 5,000) from the day of the operation, and metal bougies are introduced with the greatest care at the end of a fortnight, the after-treatment then proceeding as above.

Ruptured Urethra

Opinion in regard to the after-treatment of this common accident is not yet standardised. It is felt, however, that the following two principles are sound and should be observed: one, that however "partial" the rupture may be, and even although a catheter can be passed into the bladder, a suprapubic cystostomy is performed to divert the urinary stream; two, that an indwelling catheter must not be used, as this irritates the suture-line or the granulations, and is a fruitful source of stricture and of urethral fistula. Whether or not

bleeding proves obdurate, the bladder will have to be opened and suprapubic cystostomy adopted.

Acute retention of urine may very rarely occur if the internal meatus is accidentally burnt. This passes off after a few days, during which time the patient is relieved by catheterisation. The patient returns for cystoscopic examination after four weeks, by which time slough and debris have been discharged and relics of the papilloma may be fulgurated again. The bladder is cystoscoped four weeks after this operation, and if all is clear he returns for cystoscopic examination every three months for a year, then every six months for another year and then annually. Any recurrence of symptoms such as hæmaturia demands a cystoscopic examination at once.

Suprapubic Diathermy

If the papilloma is large or if for any other reason, such as suspected malignancy, the operation is conducted through a suprapubic opening, then the after-treatment is as for cystostomy. Constant irrigation will not be required unless there is hæmorrhage or sepsis, but twice daily washings of the bladder should be carried out. The drain in the cave of Retzius is as usual removed after four days and the suprapubic tube may be removed in a week, the opening being then allowed to close. The patient may be allowed up when the suprapubic wound has been dry for three days. Patients are examined periodically by the cystoscope after this operation as after the transurethral coagulation.

VII. THE URETHRA

Internal Urethrotomy

After the operation an indwelling catheter is usually retained for forty-eight hours to avoid contaminating the site of the stricture with urine. The patient is kept in bed for a week, and if the urine is infected, as is usually the case, the urethra is washed out twice daily with silver nitrate solution (1 : 10,000), or mercury oxycyanide (1 : 5,000). A mixture containing acid sodium phosphate gr. x is prescribed three times a day before meals for a month. After fourteen days a bougie, size 22/26 French (Charrière), is passed. The instrument is passed again at the end of another fourteen days and the interval between passing the instrument is then successively increased to four, six and eight weeks, then three, four and six months, and when the bougie can be passed after an interval of a year without contraction of the stricture occurring in the interval, then the patient may be pronounced cured.

The Drainage Tube

The drain is removed after forty-eight hours, and as there is now no longer any danger of a hæmatoma forming, the spica bandage can be discarded.

Support of the Scrotum

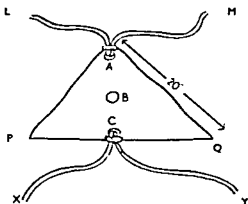


Fig. 40*a*.—The scrotal support.

The scrotum should be supported by a triangular bandage. This bandage is arranged so that the hypotenuse passes under the scrotum, over the anterior superior spines and round the back, the ends being knotted so that the knot is at the side and the patient does not lie on it. The right-angle and adjacent sides are then gathered up over the scrotum and penis, elevating and supporting them, and are pinned together over the pubis. A far better method, although somewhat more elaborate, is to take a piece of lint about 20 inches square, fold this diagonally and cut three holes at A, B, and C (Fig. 40*a*). Two bandages each 5 feet in length are attached by their centres at A and C (AL, AM and CX, CY). The hypotenuse PQ is then passed under the scrotum and the right-angle A is pulled up towards the umbilicus, the penis passing through the hole B. AL is then led round the waist and tied firmly to Q, AM passing round the opposite way and being tied firmly to P. The perineal bandages CX and CY are then taken up between the legs and fastened to the waist-bands like the perineal straps on a truss (Fig. 40*b*). These methods are to be preferred to a sandbag under the scrotum, as the former tends frequently and rapidly to become a sandbag on top of the scrotum as the patient shifts in bed. An ice-bag placed up against the triangular bandage often relieves the pain.

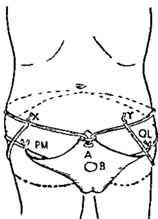


Fig 40*b*.—The scrotal support in position.

Fluids are given freely, the bowels are kept open and sleep is regulated according to general principles. These patients may be got out of bed in a week or earlier if possible, and may be fit for discharge in a fortnight.

repair has been attempted to the urethral wall, the after-treatment is the same. Acid sodium phosphate is prescribed as above. The suprapubic tube is retained for a fortnight and the urethra is gently irrigated with silver nitrate solution (1 : 10,000) or mercury oxycyanide (1 : 5,000) twice a day. At the end of a fortnight a bougie, size 18/22 French (Charrière), is passed gently into the bladder and removed, if necessary under an anæsthetic. Provided the passage is deemed satisfactory the suprapubic wound may be allowed to close. If the passage-way is narrow and "rugged", the cystostomy opening should be maintained for another week, when a fresh attempt may be made to pass a bougie, and the urethral aperture may be dilated sufficiently to allow the suprapubic wound to close. Instrumentation is then practised as after urethrotomy.

VIII. THE TESTICLES

Hydrocele

The commonest operation on the testicle is for hydrocele of the tunica vaginalis. For such a seemingly minor operation on a structure outside the abdominal or thoracic cavity the post-operative course may be a peculiarly troublesome and anxious one. If the patient is an elderly man with incipient prostatism there is difficulty with micturition. Some degree of scrotal hæmatoma is the rule, although a drain is put into the scrotum; and the pain causes sleeplessness and loss of morale. Chest complications often arise and complete the picture of ageing misery Nevertheless the alternative is to tap the hydrocele at varying intervals, and this method of treatment carries with it many disadvantages, so that the operation is one that may have to be performed on patients past middle-age.

Passing Urine

It is a wise precaution to let the patient wear a firm spica bandage before the operation so that he can practise passing water in defiance of this restriction At the conclusion of the operation the scrotum is bandaged firmly to the abdominal wall in order to control oozing from the cut surfaces, care being taken to see that the penis is as free as possible. In twelve hours' time the patient is encouraged to pass water, using all the devices suggested on p. 14. In order to promote this the spica bandage may be temporarily loosened, but it must on no account be removed for more than a few minutes at this stage, after which it is reapplied as firmly as before. If water has not been voided in eighteen hours, a catheter must be passed.

sixth day. If unabsorbable stitches have been used, these should be removed on the fourth day and a fresh dressing applied until the sixth day.

Sepsis is very rare, but hæmorrhage is sometimes troublesome. Should hæmorrhage not abate spontaneously, it is best in infants to explore the wound and insert a stitch to secure the bleeding point without resorting to any of the conservative measures which might be suitable in an adult.

Injury to the meatus is treated by dilating this daily with a glass rod smeared with Vaseline until it has completely healed. In neglected cases a plastic operation can be performed followed by daily dilatation.

Adults

When circumcision is performed on adults, non-absorbable sutures are used. The ends of these can be left long and tied over a dry gauze sponge. This gauze sponge should not be soaked in Tinct. Benzoin. Co. because the resulting dressing is too harsh and constricting for the adult organ. This is the classical "anchor dressing", but it is not altogether desirable, because the stitches tied over it tend to hold the dressing away from the raw surfaces which are therefore more likely to become infected. A better plan is to leave the stitches long, to start bandaging the penis with a Vaseline gauze from the proximal end and when the level of the sutures has been reached to turn these back on to the gauze. The dressing is then continued over the wound and the proximal portion of the glans and is completed by bringing the Vaseline strip back over the stitches, binding them in. A pad and a T bandage hold this in place. Stitches are taken out on the fifth day and a Vaseline gauze dressing kept on for a week. Full doses of bromide are given to prevent erection.

Hæmorrhage is treated first by raising the foot of the bed, applying an ice-bag to the part and giving a quarter to a third of a grain of morphia. Should the bleeding continue, the patient must be taken to the theatre and, under a general anæsthetic, the bleeding point is sought and secured.

COMPLICATIONS

If a *hæmatoma* forms in the scrotum it tends to spread into the inguinal regions and up towards the flanks. Without causing much pain it seems to determine a general deterioration in the patient's condition, possibly due to the circulation of the toxic products attendant on its absorption. It is usually quite fruitless to attempt to evacuate the hæmatoma, as it is generally a diffusely spreading, thin film of blood which never collects in sufficient quantity in any one place to be able to drain it. General measures must be adopted to prevent fresh oozing and the patient's strength must be maintained. Rarely the hæmatoma becomes infected, in which case suppuration is the rule and incisions will eventually be required with a correspondingly worse prognosis. Chest complications are dealt with in Chapter V.

Orchidectomy

Orchidectomy and epididymectomy for tuberculosis or neoplasm are not followed by such a stormy convalescence. The patient is usually younger and in orchidectomy there is no cut surface of a thick tunica vaginalis from which hæmorrhage can occur. Scrotal hæmatoma is, however, always a possibility, especially as, in epididymo-orchidectomy for tuberculosis, a drain will probably not have been inserted into the scrotum. The after-treatment in cases of tuberculosis may include a sanatorium regime if there is evidence of tuberculous infection elsewhere.

IX. CIRCUMCISION

Infants

This operation is usually performed upon infants. The wound can be dressed with a Vaseline gauze strip or with a gauze strip impregnated with Tinct. Benzoin. Co. A pad of wool is placed over the penis and scrotum, and this is held in place by a T bandage. There is little to choose between Vaseline and Tinct Benzoin Co. A strip impregnated with Tinct. Benzoin Co. is perhaps somewhat less likely to become detached than one impregnated with Vaseline. On the other hand it is painful to replace when the infant is not under an anæsthetic. A good compromise is to use Tinct Benzoin. Co. immediately after the operation, when it may help to control the bleeding, and to use Vaseline if and when this comes off If catgut sutures have been used to secure the skin to the mucous membrane, then the dressing need not be discarded until it comes away in the bath on about the sixth day. If it comes away earlier, a Vaseline dressing should be replaced until the

further month. In amputations through the *upper limb* the position adopted in the first few days after operation is important. In high arm amputations adduction deformity must be prevented by active exercises and, if necessary, by bandaging a triangular orthopædic wedge into the axilla. In high forearm amputation flexion deformity is prevented by active exercises and by wearing a splint at night.

Movements and Exercise

Unless infection is present gentle movements of the adjacent joint may be practised in four days. These movements gradually increase in range and, by making them against resistance (Fig. 41*b*), in power, so that at the end of four weeks the stump will move freely and will be manned by muscles which have recovered their tone and much of their strength. During these four weeks and as a result of the exercises, which should be undertaken for twenty minutes three times a day, together with firm bandaging from below upwards with an elastic bandage, the stump will have shrunk from loss of œdema fluid and will have become firmer as a result of the increased tone in the muscles. Massage is of doubtful value in helping these processes and may indeed do harm by irritating the nerves and leading to neuritis. At the end of the four-week period the stump will have approximated to its final conical shape (Fig. 41*c*), but variations in contour must be expected for a further five or six months.

The Prosthesis

In amputations through the lower limb the problem now arises as how best to allow the patient to get about. The use of crutches, although necessary at first, does nothing to increase the power of the stump or to accustom the patient to its use in walking and some form of prosthesis should be supplied at this time. It is most important whilst the crutches are being used and the stump is dependent that it should be firmly swathed in an elastic or crêpe bandage so that a postural œdema is prevented. There are two opinions as to the correct procedure. One school of thought advises the use of a *temporary pylon*, made nowadays of a fibre cone, until such time as the stump has assumed its final shape and a permanent limb may be fitted. The other school advises the use of *the final prosthesis* from the fourth to the sixth week onwards, making small adjustments to the shape of the socket as these become necessary during the ensuing months. The great disadvantage of a temporary pylon is that it does not have a forward-protruding foot-piece. The patient misses the support of this and with each step forward on the pylon tends to throw the shoulder

CHAPTER X

AMPUTATIONS AND OTHER OPERATIONS ON THE LIMBS

I. AMPUTATIONS

THE immediate after-treatment of a patient who has undergone an amputation will be in accordance with the general principles already discussed. Pain is often severe and morphia should be prescribed freely so that "association paths" are not developed which will lead to protracted after-pain and "phantom limb". Drainage tubes are usually employed and these, serving to prevent hæmatoma formation, may be withdrawn half-way in forty-eight hours and completely removed after seventy-two hours. The stitches can come out after seven days. Some surgeons apply a *plaster-of-Paris* cast to the stump. This cast, which includes the adjacent joint in the first instance, has to be removed after seven days so that the stitches can be taken out. When it is reapplied the adjacent joint is left free so that active movements may be undertaken. This method of treatment is not to be recommended, as it entails difficulty with the drainage tubes, which must either be dispensed with altogether or left in for a week, by which time a tunnel lined with granulations will have formed, leading down to the bone-end, and this may encourage osteitis. Further, an inelastic plaster cast cannot exert even pressure on a shrinking stump and an elastic or crêpe bandage is to be preferred (Fig. 41*a*).

Position

In amputations through the *thigh* the greatest care must be exercised from the first to prevent flexion deformity of the stump. The common practice of nursing these stumps on a pillow is bad, since the combination of the elevated stump and the sitting posture flexes the hip to a right-angle or more, and full extension, especially of a short stump, may be hard to regain. Rather the patient should have the buttock supported by a ring-pillow and the stump should be held down in extension by a towel and sandbags. Similarly the tendency to flexion at the knee in an amputation through the *leg* must be controlled by a back-splint which is worn day and night for a month (being taken off when the knee-joint is exercised) and at night only for a

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temporary pylon is seldom exact and rolls of flesh may develop to embarrass the fitter when the time comes to adopt the final prosthesis. Most surgeons now agree that the patient should be put in the hands of the artificial-limb maker from the fourth week and that a permanent prosthesis should be used from that time. The quite inexpensive and minor adjustments which have to be made to the socket can then be left to him.

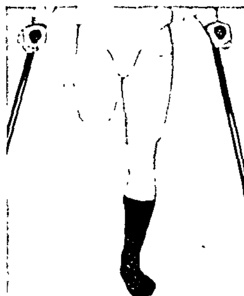
Care of the Stump

The stump must be kept scrupulously clean by daily washing with soap and water. Every care must be taken to see that the socket of the artificial limb is an accurate and comfortable fit. There are, however, areas of unavoidable pressure and in the care of the stump particular attention must be paid to these. Pressure-points should be gently massaged with the soapy hand to clean the skin and to promote the circulation. They are then dried, and methylated spirit is dabbed on and allowed to evaporate. The whole stump should be powdered with talc twice a day. The stump is covered by a sock made of stockinette, and this should be changed every other day or more frequently in hot weather. As soon as the sock becomes harsh and shrunken from washing it should be discarded. If the stump perspires it should be sponged with cold water, dried and powdered, and a clean sock put on.

In putting on the artificial limb great care should be taken to see that there are no creases in the sock. Often it is advisable to attach tapes to the bottom of the sock and lead these tapes through a hole in the socket of the limb. Traction on the tapes will then pull out any creases in the sock and the tapes may be tied to the artificial limb.

Re-education

With a properly fashioned stump and a perfectly fitted prosthesis an artificial lower limb can be a very limited disability. Firstly the patient must learn to walk. The tendency is inevitably to throw the weight on to the sound limb at first. Conscious endeavour must continually be directed towards distributing the weight evenly between the two legs. A stick should not be used, and when the patient feels the need for additional security he should, in an amputation through the thigh, learn to lock the knee by pressure of the stump backwards against the socket. The eyes must be kept off the ground and the shoulders braced back, and soon the artificial limb will form as much a part of the patient as the pen in the hand of a writer. It is far better to walk a hundred yards properly than a mile "any old how".



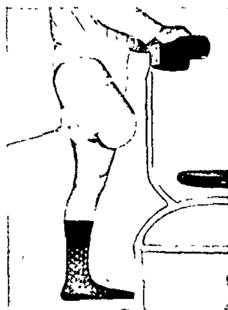
(a)

FIG. 41.

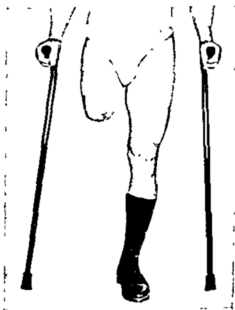
(a) The stump bound from below upwards compressing the flesh into the desired taper shape.

(b) The Desoutter Elastic Exerciser. The stump should be exercised in all directions for twenty minutes two or three times daily.

(c) The stump after six weeks' use of the exerciser, showing the extensive shrinkage of the flesh and redevelopment of muscles.



(b)



(c)

backwards and arch the back, a habit which may be impossible to eradicate and leads to lordosis. Furthermore in an amputation above the knee, the pylon, not being articulated at knee level, has to be swung outwards with each forward step. Finally, the fitting of a

the vertical and the knee bends, the front portions of the foot will naturally point down; it is to allow this movement to take place that the heel must be placed forward on the step in such a position as to allow the instep of the shoe to roll over the edge of the step. Experiment first on the bottom steps till you get the necessary confidence to enable you to go forward on the straight artificial limb (Figs. 42 and 43).

" How to drive a Car

" It should not be necessary even for above-knee amputees to resort to gadgets and hand-controls for driving a car, provided they have a long enough stump to work the clutch pedal. The advantages of not having to rely on a specially fitted, non-standard car are obvious, and hand-control of a car is sometimes dangerous, as it may involve releasing the steering wheel at a critical moment. The seating should be sufficiently low to enable the artificial limb to be slightly bent; . . . this means that downward pressure of the stump tends to push the clutch out owing to the straightening and consequent lengthening of the limb. Given a sufficient length of stump and a little practice, this downward pressure of the stump will be found quite easy. . . . When placing the foot on the pedal ready for driving, the shoe should, if possible, be brought up until the heel catches on the bottom edge of the pedal. As one tends to lean back against the seat when de-clutching, to obtain leverage for the stump from one's shoulders, it is necessary that the gear lever should be within easy reach of the hand; this eliminates the necessity of leaning forward when changing gear.

" The above hints apply to those who have lost the left leg. Those who have lost a right can easily have the connections on the pedals reversed, resulting in the right-hand pedal becoming the clutch pedal. For although an artificial limb can be used as already described for the brake pedal, this method of driving must be condemned, firstly, because the stump is incapable of exerting the pressure required in an emergency, and secondly, because there is always the danger of the artificial foot slipping off the brake pedal, with calamitous results; whereas should it slip off the clutch pedal when used as described above, this would in no way interfere with pulling up. Also for these cases the accelerator pedal, if fitted on the right, should be moved to the left.

" Owing to the weight of the limb being constantly on the clutch withdrawal fork, the return spring of the clutch pedal should be sufficiently strong to support the weight of the limb, thereby keeping the clutch lever off the fork; if necessary an auxiliary spring should be

Mr. Desoutter, in his excellent book *Back to Activity*, has some special advice to offer patients with artificial limbs and the following is a quotation from this work:

"How to go Downstairs

"The following hints will show above-knee amputation cases how to go downstairs normally instead of with a stiff leg one or two steps at a time. The start is, of course, made with the artificial limb, which should be put on the step below the one upon which you are standing,



Fig 42.—Above-knee amputation going downstairs The heel is placed well forward on the tread of the stair with the instep over the edge of the tread.



Fig 43.—Placing the heel well forward allows the foot to roll over the tread of the stair when the knee bends. The limb is then kicked forward and the action repeated.

with the heel *as far forward and as near the edge of the step as possible.* Then, whilst keeping the shoulders well back, allow the body to go straight forward, making no attempt to bend the artificial limb, but allowing it to remain straight until it bends of its own accord, when the good foot should be ready to come down on to the next step. If, when coming forward, the body is not kept upright and the shoulders well back, the knee will not bend soon enough. As soon as the good foot is on the next step the artificial limb should be kicked forward as when walking and the heel placed on the next step, again as far forward as possible. A little practice will quickly enable you to place the heel in the right position at every step. When the artificial limb has passed

ten pounds traction is then applied. Another method is to encase the limb in stockinette which is fixed to the skin with collodion over the whole of the area covered, and has an excess of three or four inches protruding beyond the stump. The edge of this excess is then sewn round a ring, 7 inches in diameter, made from the lid of a large tin from which all but the rim has been removed. Cords take purchase at four equidistant points on the ring and are used for traction. When a dressing is required, the weights are lifted and the ring is passed up over the stump carrying the excess stockinette with it. The open wound is dressed with paraffin flavine or Eusol, and the strapping extension or stockinette is renewed as it becomes sodden and detached, a fresh area of skin being used whenever the strapping is changed. As the granulations become more healthy, Lotio Rubra may be used in place of the paraffin flavine or Eusol as a dressing. In about four to eight weeks the end of the bone will separate as a "ring sequestrum" and with adequate extension of the skin it may be possible to practise secondary suture of the skin edges over a rubber drain. Sometimes the skin traction will not produce sufficient skin to cover the bone-end even after the ring sequestrum has been discharged. This is particularly the case with short stumps, and then secondary amputation is usually necessary at a higher level, although rarely a pedicle flap may be swung across from the opposite leg to make good the defect. These secondary operations should only be considered when sequestra have separated, œdema has subsided and the stump is covered by clean granulations.

Complications

A painful stump may be due to a badly fitting prosthesis, to painful terminal neuromata, to causalgia or to "phantom limb". After every precaution has been taken to see that the limb fits snugly and that there is no chafing, a differential diagnosis of the other causes of painful stump must be made. Pain of the "*phantom limb*" type is projected to some part of the missing member and may closely simulate the pain for which the amputation was performed. Pain of this type does not respond readily to any form of treatment, but fortunately it usually disappears spontaneously after a variable period. If the *pain is localised to the stump*, then there are two main syndromes which should be distinguished: first, where the pain is unassociated with trophic changes and is abolished by the injection of a local anæsthetic; and second, where trophic changes coexist and where the injection of a local anæsthetic has no effect. In the former of these two, treatment is of little avail. Resection of the terminal neuroma, section and sub-

fitted, otherwise there may be excessive wear on the withdrawal ball race."

Emergency Amputations

In cases of gas gangrene or other severe infection, some surgeons adopt the life-saving measure of *the guillotine* amputation, whereby all structures are cut through at the same level and the wound is left entirely unsutured. Other surgeons believe that the same effective drainage can be obtained with very little extra trouble by fashioning *skin flaps* and suturing these together loosely over a Vaseline-impregnated sponge, the end or ends of which protrude at the angles between the flaps. In the latter case it may be possible to withdraw the sponges in two or three days and delayed primary suture of the unstitched portions of the flaps may be practised, using the technique of local penicillin instillation described on page 34. The treatment of such an amputation may then proceed as described above. If, on the other hand, the emergency amputation has been performed at a level unsuitable for a permanent stump, as for instance through the knee-joint, then secondary amputation will have to be performed at a later date. In such a case secondary amputation should be deferred until healing is well advanced and sepsis has been overcome.

Skin Traction

If the guillotine type of amputation is performed, then steps must be taken to prevent retraction of the skin. This may be effected by applying four strips of adhesive strapping longitudinally to the stump twenty-four hours after the amputation. These four strips are bound to the limb by Elastoplast passing circumferentially (Fig. 44), and are so adjusted that they take purchase as near to the skin edge as possible. Tapes or cords are attached to the free ends of the longitudinal strips, and may be tied to the end-piece of a short Thomas' splint. Seven to

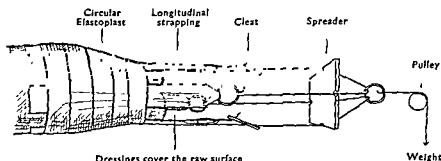


Fig 44.—Distraction apparatus for a guillotine amputation.

greater value than passive movements and *the latter should only be conducted by the patient himself* to assist and encourage the former. These movements performed by the patient I will call "auto-passive" movements. The patient should be instructed to concentrate particularly on the accessory movements of gliding, rotation and distraction which cannot be performed voluntarily and to mould the finger as in putting on a tightly fitting glove, and such movements should be carried out with the greatest gentleness. Nothing in the way of breaking down adhesions by manipulation under an anæsthetic should ever be performed on the fingers. Finger movements are easier to perform if they are made in hot water. If the whole hand is immobilised, then the wrist should be put up in slight extension.

Amputations

No particular problems present themselves after amputation of fingers provided the above principles are observed. Movements of the stump can be started in four or five days and the patient is encouraged to prevent the remaining fingers from becoming stiff by active and auto-passive movements from the start.

Tendon Suture

After repair of a ruptured tendon a balance has to be struck between movement of the finger after union is sound and movement of the finger before adhesions have formed. Experimental work has shown that after tendon suture there are three distinct phases. During the first, which lasts for five days, the union decreases in strength; during the second the union rapidly becomes more secure until about the third week, after which the last phase consists in a slow consolidation which may go on for many weeks. Gentle active movement may be practised after fourteen days, when the second phase is nearly complete and may be assisted by auto-passive movements under water at the end of three weeks. Movements are designed to increase gradually in strength and range. From the first day the remaining fingers are put through their full range of active and auto-passive movements twice daily. Experiments have shown that no benefit accrues from attempting to move the sutured tendon before fourteen days, as the irritation caused serves to increase the adhesions of the tendon to its sheath or to the surrounding structures, and the range of movement will become progressively reduced.

The prognosis of extensor tendon suture is excellent. The results of suture of flexor tendons are less satisfactory if the tendon has been divided within its sheath; but if the division is opposite the neck of

sequent suture of the nerve higher up and such heroic procedures as injection of alcohol into the subarachnoid space or antero-lateral tractotomy have all been tried without much success. In the latter, if the pain is associated with vaso-motor disturbances, then *sympathectomy* may be tried. In both types of pain time may bring relief.

Painful and adherent scars should be widely resected and the skin undercut and sutured in such a way that the suture-line is well away from the area where the skin was previously adherent. Skin flaps from the same or the opposite limb may be necessary.

Eczema or intertrigo may develop in the corrugated skin of a stump. This may be treated in the first instance by applications of Ung. Hydrarg. Ox. Flav. 2 per cent., and later by careful washing with soap and water and the application of talc powder. The bone-end sometimes gives rise to trouble. An *osteomyelitis* may persist and necessitate resection of the end of the bone. This is best performed through a fresh incision approaching the bone from the side. A *spur* may need removal if it is giving rise to symptoms and multiple spurs may demand excision of an inch or more from the bone-end. In performing these operations the periosteum should be disturbed as little as possible. Occasionally a painful *bursa* develops over the head of the fibula, and this can be cured by removal of that part of the bone.

The detection and treatment of *gas gangrene* is discussed on p. 41, and *secondary hæmorrhage* on p. 48.

II. THE FINGERS AND HAND

General Principles

Operations are undertaken on the hand for the removal of damaged tissue, for repair of injury and to let pus.

Certain general principles must be observed in the surgery of the hand. Fingers should not be immobilised for longer than is absolutely necessary, and the immobilising apparatus should be so designed as to give the remaining fingers as great a freedom of movement as possible, a freedom of which the fullest advantage must be taken. Thus all joints in the free fingers are systematically put through their full range of movement twice each day, and in the convalescent stage the patient carries about a block of sorbo sponge on which he continually exercises his fingers. A finger should never be immobilised in the extended position, but with each joint partially flexed so that the finger forms a gentle curve with the alignment of the distal phalanx at right-angles to the plane of the palm. Active movements are of much

suppuration, especially in staphylococcal infections. Zinc ionisation is a method of bringing the antiseptic zinc ions into contact with the wound. Its place has now probably been quite usurped by penicillin.

A *chronically discharging sinus* may be due to necrosis of bone, to sloughing of tendon or, in the case of the finger, to spirochætal infection. The part should be probed and sequestra may be felt. An X-ray examination will reveal dead bone and it will probably hasten healing if the sequestrum is removed by operation. A sloughing tendon can usually be seen at the bottom of a wound or it may be partly prolapsed through it. Healing is again expedited by performing an operation to excise the tendon. Any chronic sore of the finger should be suspected of being a primary chancre and a culture taken and examined for spirochætes. A Wassermann or Kahn reaction will only become positive after some weeks.

PROGNOSIS

The prognosis of finger and hand infections is good provided the correct surgical procedure has been practised in time and if the infection is confined to subcutaneous and cellular tissues. Pyogenic infection of joints and tendon-sheaths has a very bad prognosis and amputation will nearly always have to be performed eventually for a stiff finger. An exception to this rule may be made in the case of staphylococcal infections of tendon-sheaths, where prompt surgery usually results in a freely moving finger, but of such infections this type is unfortunately rare.

Residual stiffness may demand regular active and gentle auto-passive movements for months. At this stage the value of making the movements in hot water is considerable. These exercises may be preceded by other measures for promoting the circulation by heat, such as short-wave diathermy or wax baths.

If *amputation* is necessary it should, if practicable, be put off until the part has healed or at least until the inflammation has become chronic. If it is necessary to perform amputation in the presence of a sinus, then the greatest care must be taken to screen this from the site of the amputation, as infection invariably leads to excessive scarring and the likelihood of a painful stump. *Painful stumps* in the hand are as unsatisfactory to treat as painful stumps elsewhere. If the pain and tenderness are confined to the scar, then relief may be obtained by re-amputation at a higher level. If the pain radiates from the stump up the finger, then a conservative attitude is usually the best. I have heard of two cases, one of which I have seen, where successively higher amputations were performed for this complaint, ending in disarticula-

metacarpals where the tendon is devoid of a sheath, the prognosis is good.

Septic Conditions

After incisions have been made into the fingers or hand to provide an outlet for pus, a drain made of rubber-glove material or gauze impregnated with Vaseline may have been inserted. It is the fashion nowadays to dispense with drainage material in infections of the fingers and hand from fear that it may give rise to stiffness, but I am not convinced that this practice has any advantage over the use of a soft drain intelligently managed and it is an innovation over which it would as yet be unwise to dogmatise. Many surgeons advise movement of the part from the first, but I believe that it is better to wait until the surrounding inflammation and œdema have subsided and to put off movements for at least forty-eight hours. In regard to the subsequent treatment, I must confess to a quaintly old-fashioned prejudice in favour of hot soaks for cleaning the wound, provided that these are relinquished as soon as the skin shows signs of becoming "soggy". For half-an-hour, therefore, four times a day the whole hand and forearm up to the elbow is immersed in a bath of hypertonic saline which is kept hot by the addition of freshly heated solution. After forty-eight hours finger movements can be carried out in the bath. A drain is left in until there is no further danger of pocketing, but should be shifted or changed each day and will in any case (unless it is a "through and through" drain) tend to come out with hot soaks, after which it may be replaced With severe infections of the hand, attention should be paid to the possibility of secondary hæmorrhage during the hot soaks. In between soaks the part is dressed with glycerine and a kaolin or Antiphlogistine poultice applied. *If hot soaks are not approved of, the incised part is dressed with* Vaseline, and some surgeons advise temporary immobilisation in plaster until exercises are required. A splint is used to keep the whole hand and wrist still, and if the patient is in bed the arm is rested and elevated on two pillows. If the patient is ambulant, a sling must be worn.

Fluids are given freely, the bowels attended to and for pain Veganin gr. x, Heroin gr. $\frac{1}{12}$ or morphia gr. $\frac{1}{4}$ may be prescribed. Parenteral penicillin is of the greatest value in this condition both pre- and post-operatively while there is still active inflammation. As soon as the patient is fit enough natural or artificial sunlight is given to the rest of the body. Short-wave diathermy is valuable as a post-operative measure if the wound becomes indolent, in order to hasten

The legal responsibility for disablement is set out in Fifield's *Infections of the Hand*, as follows:

"A workman is covered by the Workmen's Compensation Act for any accident which he may incur while at work or on his employer's premises. Under the Act he may receive half his weekly wage, with a maximum of 30*s*. a week, during the period of his total incapacity. Provided it can be shown that the infection (or injury) followed an accident at work, then during treatment both of the injury and of any complications, he is covered by the Act and gets compensation. It is important, when preparing certificates for these men, to avoid the term 'whitlow' and use that of 'septic hand', as compensation may otherwise be lost because of widespread recognition of the possible spontaneous origin of whitlow.

"A 'beat' hand (a chronic subcutaneous cellulitis) and chronic teno-synovitis (not an acute infective teno-synovitis) are scheduled diseases in miners. This means that no antecedent injury need be proved by a miner before drawing weekly compensation under the Act when suffering from one of these conditions.

"After six months' full compensation has been paid, it is open to the employer to apply to the Court for an order to redeem the weekly payments by a lump sum which is three-quarters of the annuity value of the weekly compensation (assessed at the current value of consols), or such sum as the workman may be willing to accept, subject to the approval of the judge. The hand infections (or injuries) which arise from accidents during the non-working hours of the workman are not covered by the Act. If he is an insured person, he is, during the period of his treatment, covered by the National Health Insurance, payments from which cease when the patient is certified fit for work. Infections arising in uninsured persons in their own employ, such as housewives, come under neither the Workmen's Compensation Act nor National Health Insurance.

"When negligence of the employer can be shown to have been a factor in the original injury, the patient then has a case at Civil Law against his employer, outside the Workmen's Compensation Act. He may obtain such damages in a lump sum as the jury may see fit to award."

III. COMMON ORTHOPÆDIC OPERATIONS

Hammer-toe

After this operation the toe is splinted by a bandage impregnated with collodion. The stitches are removed in a week and a fresh

tion through the shoulder-joint without relief of symptoms! One of these was eventually relieved by antero-lateral tractotomy, the other was not relieved of his pain by this measure, but died as the result of the operation. An exception to this conservative attitude may sometimes be made in the case of a painful stump, the result of amputation through the metacarpo-phalangeal joint. In three such cases I have removed the unsightly painful distal third of the metacarpal with excellent results. Massage should not be given, as this will serve only to increase the irritation of the digital nerves. The part should be rested, except for gentle exercises twice a day, and radiant heat may be soothing. Fortunately, following this regime the pain usually disappears or abates in the course of a few months. If as a result of the rest it has now become stiff (though painless), a finger may be re-amputated with safety. Certain surgeons advise section of the thoracic sympathetic chain for this complaint, but there is a natural disinclination to advise so radical an operation for what seems to be a trivial lesion of a finger. There is undoubtedly, in many of these cases, a psychological factor, and this is further argument in favour of conservatism.

Permanent Disability

In assessing permanent disability after lesions of the fingers and hands, two main standards must be recognised, the physical and the economic. Thus the oft-quoted violinist with an amputated terminal phalanx of his left index finger is completely disabled economically whilst his physical disablement is negligible. Conversely, an author with an amputated left hand has considerable physical disablement, but is economically sound. The position is further complicated by the state of the labour market. Thus a workman with an amputation through the middle finger may be perfectly fit to continue his work, but is quite unable to find employment because the market is glutted with whole-handed men of the same calling. In assessing compensation, judges appreciate this difficulty, and all these factors in disablement—the economic, the physical and the "comparative"—are taken into consideration.

The period of disablement in finger and hand lesions can only be judged by the progress of the case. There is great variability and the possibility of amputation must always be borne in mind. A stiff finger is usually a more serious disability than a missing finger. Loss of the thumb reduces the value of the hand by 50 per cent., loss of the index finger by 20 per cent., and loss of the other fingers by 10 per cent. each. In this connection the "value" of the hand takes into account both the strength of the grip and the capacity to perform delicate movements.

dispense with the pressure-bandage, but its value in preventing hæmorrhagic or serous effusion into the knee-joint is undeniable.

On the day after the operation the patient practises quadriceps exercises (p. 230). On the tenth day the pressure-bandage is removed and the stitches are taken out. A gauze sponge is placed over the incision and this is kept in place by an Elastoplast bandage which encircles the knee-joint from a finger's breadth above the upper border of the patella to the tibial tuberosity—no higher and no lower. It is usually wise to test the patient's skin-reaction to Elastoplast by placing a square of this on the flexor aspect of the forearm for a day or two before it is necessary to apply it to the knee. If the Elastoplast is too much for the skin, then a crêpe bandage or Fripp's elastic bandage may be used instead. The patient starts active movements of the knee-joint itself from the tenth day and quadriceps drill is persisted in until the tone of these muscles is equal to that of the other side. Massage and faradism may help, but can never replace active exercises. Weight may be borne after the tenth day as soon as the patient can raise the straightened leg against about a ten-pound downward pressure on the ankle-joint. After six to eight weeks the leg should be normal and football can be played after ten weeks. When the external [illegible]

[illegible] of the joint, and it may be some twelve weeks or more before the knee is sufficiently sound to allow such strains as those imposed by football Elastoplast, elastic stockings or crêpe bandage should be discarded when the tone of the quadriceps has been regained. During convalescence and if conditions are suitable, swimming is one of the most valuable exercises for knee cases. A table of special knee exercises is given in Chapter XIV.

FRACTURED PATELLA

After operations for fractured patella a pressure-bandage is employed for ten days until the stitches are removed. The leg is then put in plaster from the upper part of the thigh to the ankle-joint and two lengths of webbing are incorporated longitudinally in the plaster, one in front and one behind. These pieces of webbing emerging from the top of the cast are buckled together over the opposite shoulder, which is protected by a leather or felt pad, and they serve to keep the plaster from falling down and pressing on the tibial and fibular malleoli. Quadriceps exercises are practised from the first day after the operation and are continued while the patient is in plaster. Walking may be allowed after the tenth day. The plaster is removed after six weeks,

collodion splint is applied. This splint is changed again after a fortnight. A third collodion splint is applied and worn for a further fortnight, when it is finally discarded after five weeks from the time of the operation. The patient may walk after a week and, in order to rest the splinted toe, a metatarsal bar, or bar of leather running obliquely beneath the metatarsal necks, is fixed to the sole of the shoe over which the foot rocks. This is worn for six weeks, that is, until seven weeks from the time of the operation and a fortnight after the collodion splint is discarded.

Hallux Valgus and Rigidus

Immediately after the operation the toe is bandaged in moderate adduction (varus), a wedge of cotton-wool being placed in the cleft between the first and second toes. The stitches are removed on the seventh day and thereafter the toes are actively exercised for five minutes three times a day. A piece of strapping an inch broad is attached to the inner side of the toe and is taken along the inner border of the foot to hold the toe in moderate flexion and adduction (varus). Another piece of strapping is passed round the foot at the level of the metatarsal heads to preserve the transverse arch of the foot. After fourteen days, gentle traction is applied to the big toe after the active exercises, and the foot is massaged. Although these patients are usually allowed up after ten days, it is better to keep them in bed for three weeks, practising active exercises regularly three times a day throughout this period. When they get up, the strapping along the inner border of the toe and round the heads of the metatarsals should be retained for a further week and the patient wears soft shoes. At the end of the fourth or fifth week ordinary shoes may be worn and a support is provided for the anterior arch of the foot and this is worn for three months. During these three months the foot should not be used extensively as it readily becomes painful. Walking should be restricted and the foot should be rested on a chair whenever possible. The full benefits of the operation are not felt for six months, when full activity may be resumed.

Semilunar Cartilage

At the conclusion of the operation for excision of an internal semilunar cartilage of the knee-joint, the part is usually swathed in a roll of cotton-wool on top of which a pressure-bandage has been tightly wound. The patient is returned to bed and the leg is elevated on a pillow. Despite this, œdema of the ankle and foot is very common and the pressure-bandage is usually painful. For this reason some surgeons

CHAPTER XI

FRACTURES

I. GENERAL PRINCIPLES

IT will not be possible, without upsetting the balance of this small book, to discuss in detail the after-treatment of all fractures. The reader will not find here any short cut to the successful treatment of these conditions nor indeed will he be able, as elsewhere in the book, to look up, for instance, Colles' fracture in the index and find a section devoted to it. Reluctantly I have decided to confine the account to the *principles* of after-treatment. In writing this section I derived much help from Watson-Jones' magnificent book, *Fractures and other Bone and Joint Injuries* (E. & S. Livingstone, Edinburgh, 1940), a book which in an earlier edition has also been my friend and counsellor in practice, and to which reference may be made for detailed treatment of individual fractures. In only two respects do I find myself at variance with the views expressed there. I cannot condemn in quite so wholesale a fashion the practice of "passive movements", and I dislike the routine use of windows in plaster casts for any kind of fracture.

With regard to "passive movements" or movements performed on a joint, but not by the muscles working that joint, I think that greater distinction must be drawn between passive movements performed by another person, for instance a masseuse, and the passive movements performed by the patient himself, which I have termed "auto-passive" movements Whilst agreeing with Watson-Jones that the indiscriminate use of passive movement is utterly to be condemned, I believe that in his laudable crusade to get rid of the disastrous consequences of ill-applied passive movement he has himself applied passive movement to the pendulum of surgical opinion and swung it too forcibly the other way. In discussing the movement of joints after fractures I shall return to this problem and indicate how far passive movements are in my opinion justifiable.

This chapter does not concern itself with the diagnosis of fractures, nor the manœuvres adopted to set the bones in place. It deals only with the principles of maintaining reduction and with the restitution of the soft parts to normal.

Sir Arbuthnot Lane stated many years ago that no London police-

and active exercises of the knee will soon allow full movement of the joint to be regained. The practice of dispensing with a plaster cast and instituting active exercises of the knee-joint from the tenth day when the pressure-bandage is removed is dangerous, as the fracture may be displaced, however firmly it may have been wired or stitched. After excision of the patella, active exercises may be practised on removal of the pressure-bandage, but this operation is attended by such a high proportion of cases of disablement due to ossific tissue developing in the site of the old patella that I believe it will probably not survive.



(a) (b)

FIG. 45.

(a) Lateral displacement. This position, although liable to cause an unsightly lump on the leg, could be left without danger of osteo-arthritis developing in the ankle-joint subsequently

(b) Angular displacement. This position must be corrected In this particular case the method of slitting and wedging the plaster was used successfully.

man who had sustained a Pott's fracture of the ankle with both lateral and posterior displacement (third degree) ever returned to duty. Such an outcome of a third-degree Pott's fracture would nowadays be the exception. Non-union of intracapsular fractures of the hip was until quite recently in the region of 50 per cent. To-day it is under 30 per cent. and the mortality-rate has been reduced to a proportionate extent. The enormous improvements in the results of fracture treatment in the last twenty years have been due to the blending of the best parts of the teaching of two apparently conflicting schools. Arbuthnot Lane in this country insisted that functional recovery depended upon the exact anatomical restitution of the fractured bone, and to ensure this he practised open operations upon closed fractures to an extent that has never been equalled before or since. His superlative qualities as a technician and the elaboration of the "no touch" or "Lane" technique ensured a satisfactory result in a high proportion of his cases and, as a consequence of his teaching, the results of fracture treatment improved immeasurably.

In France, Lucas Championnière maintained that perfect anatomical reduction was not so important as the maintenance of physiological activity. His fractures were treated on light splints, which were removed daily for massage and exercise of the joints adjacent to the fracture. To-day we realise that neglect of either of these principles leads to unsatisfactory and sometimes crippling results. We see that in certain fractures, such as those of the shafts of the tibia and fibula, exact anatomical reduction is of more immediate concern than the maintenance of physiological activity, whereas in others, such as fractures of the neck of the humerus, complete functional activity may be attained, provided exercises are started early, without absolute anatomical reduction. But in all fractures we endeavour to achieve both desiderata. The first principle of after-treatment is that the *fracture must be immobilised until it has united, and the second, that all* adjacent joints not immobilised must be actively moved from the first.

We have stated how in fractures of the shafts of the tibia and fibula exact anatomical reduction is of the first importance, but of the two factors, angulation and lateral displacement, it is in the reduction of the former that no error may be allowed (Fig. 45). Some degree of lateral displacement may be permitted in the bones of the lower limb, although this may lead to unsightliness in the case of the tibia and must be avoided if possible, but the smallest degree of mal-alignment will inevitably cause arthritis of the neighbouring joints in after years. To check the alignment in fractures of the tibia and fibula, it is sometimes said that the line of the ankle-joint must be at right-angles to the

circle. In doubtful cases the very existence of a supracondylar fracture in the indefinite bones of children may be diagnosed by this sign.

Mal-alignment of a fracture of the femur, which is being treated by traction on a Thomas' splint, with the leg below the flexed knee supported by a "leg-piece" may often be readily corrected by moving the butterfly-screw attachment of the "leg-piece" to the Thomas' splint up or down on one side. Reference to Fig. 53 will make this manœuvre clear.

II. PLASTER-OF-PARIS

Plaster-of-Paris is used in the immobilisation of most fractures. A discussion of the technique of applying plaster is not within the scope of this book. The cast may be skin-tight or lightly padded. Each turn is "laid on" and not "bandaged on", and the plaster is sufficiently wet so that the whole cast sets in a solid mass and there are no layers. Some surgeons split the plaster down the front throughout its length as soon as it is half-set and this facilitates removal subsequently. A thin film of plaster should be left at the bottom of the slit, thereby completely encircling the part, so that there is no danger of damage to the skin by the cut edges of the plaster. The patient is returned to bed with the limb elevated. In the upper limb the encircling plaster leaves the metacarpo-phalangeal joints exposed, but in the lower limb the cast is prolonged so that the metatarso-phalangeal joints are just included. If this is done, and if the limb is elevated for the first twenty-four hours, œdema of the extremities is not usually serious. Should it occur, it is an indication for vigorous active movements of the fingers or toes.

There has been much dispute as to whether the sole of a foot-plaster should be prolonged to just beyond the toes. In plasters of the hand, the fingers should be left free to clench the fist and it is argued that the toes should be granted a similar freedom. In reply one might say that, whereas throughout life one frequently clenches one's fist, and occasionally one's teeth, it is extraordinarily rare to have to clench the feet, and the natural action of the toes is to press on to a firm surface. Further, the use of such a platform enables a "rocking hoop" type of walking appliance to take purchase further forward and leads to a more natural gait, while footballers kick the ball with either foot fortified by the confidence which a platform engenders. If a platform is not used there is a tendency for the toes to be compressed by bed-clothes when the ankle is fixed at right-angles, and a somewhat cumbersome hoop is sometimes rigged over the toes to prevent this. In any case, like so many questions which

line of the shaft of the tibia. This is nearly always true, but in some individuals the line of the ankle-joint slopes slightly upwards towards the fibula, and if there is any doubt on this matter an X-ray photograph of both legs must be taken for comparison, and the alignment of the



FIG 46 —Lateral view of the humerus showing how the anterior border projected downwards bisects the circle formed by the trochlea.

fractured leg matched with that of the other side. In supracondylar fractures of the humerus the projection of the anterior border of the humerus in the lateral X-ray photograph is seen to bisect the circular shadow of the trochlea (Fig. 46). Where the lower fragment is angulated backwards, this line will pass anterior to the centre of this

X-ray Control

As soon as possible after applying the plaster the fracture is X-rayed to re-examine the reduction. In most cases if reduction is unsatisfactory it is better to take the plaster off, reset the fracture and apply a fresh cast. This practice is in no sense a reflection on the skill of the surgeon; it is only an indication that he is not satisfied with a poor result. In some cases of fracture of the tibia and fibula with slight angulation it is possible to adjust this without removal of the plaster. These fractures are so treacherous that in an endeavour to improve on a position which is not quite satisfactory the surgeon may, by removing the plaster completely, make matters worse. In such cases the plaster may be split circumferentially for two-thirds of the way round at the site of the fracture, so that the centre of the split lies opposite the summit of the receding angulation. Wooden blocks are inserted into the split, making sure that the wood is not thrust in so far as to press on the skin, and the position is checked by X-ray examination. When the right size of block has been found and the angulation is overcome the slit may be filled with a narrow plaster bandage folded so as to fit into it and then covered with two or three turns of wide plaster bandage.

Every fracture is X-rayed again in a fortnight's time. This is especially important in the case of Colles' fracture, where perfect reduction and a skin-tight plaster may delude the surgeon into thinking that slipping of the fragments is impossible. At this time if the fracture has slipped and the position is unsatisfactory it may be corrected by manipulation. After this time, and especially in Colles' and Pott's fractures, correction of misplacement by manipulation becomes progressively more difficult and after four weeks it may be impossible.

Change of Plaster

If the plaster was put on originally in the presence of œdema, it must be changed after three weeks when the œdema has subsided, as by this time it will be loose. Otherwise plasters can be retained, if necessary, for as long as they remain unbroken and effective, often a matter of eight weeks.

Open Fractures

In open fractures the after-treatment is the same as in closed fractures, but, whether the open fracture is an early one which has been stitched up or a late one which has been left open, a

generate heat, provided the toes are exercised, results have convinced me that there is not much to choose one way or the other.

Circulatory Disturbances

Every hour throughout the day and night for the next forty-eight hours the extremities are inspected to see that the circulation is adequate. Signs of inadequate circulation are failure of the capillaries to refill in a matter of a few seconds when the part is blanched by pressure with the finger; and later, blueness and coldness. Should these signs appear, the plaster must be split from top to bottom for the whole of its depth and prised open. In moderate degrees of œdema of the toes it is justifiable at first to split the plaster for three or four inches along the lateral border of the foot and prise it slightly open. If circulatory failure persists, it may be necessary to remove the anterior half of the cast. Neither for the relief of circulatory failure nor for œdema is it wise to cut away portions of the plaster from the distal end. The cause of the trouble is nearly always higher up, as on the dorsum of the ankle-joint or on the flexor aspect of the elbow, and this manœuvre does nothing to relieve pressure at these sites. An exception to this rule, however, may be made where, as on the dorsum of the metatarso-phalangeal joints or metacarpo-phalangeal joint of the thumb, the plaster is cutting into the œdematous flesh. The cutting away then serves to relieve the pressure on that particular area, and in the case of the thumb to allow freer active movement, but it must be remembered that of itself it has no direct effect on the cause of the circulatory disturbance or on the œdema. Trimming of the plaster may be necessary later to give unencumbered movement to joints which require active exercise. For instance, in a below-the-elbow plaster a semi-circular area may have to be cut out of the top of the plaster over the radial aspect of the forearm to prevent pressure when the arm is flexed and to give free movement to the elbow-joint. Such trimmings mean that the plaster has been improperly applied in the first place, but to forestall them demands a degree of perfection to which many surgeons aspire but few attain.

After the first forty-eight hours the extremities must be inspected in the morning and again at night. Sister Gale, who was for many years in charge of a large accident ward at Guy's, made a habit of doing a routine "extremity-inspection" round first thing in the morning when she came on duty and last thing at night before going off. This practice, besides giving healthy exercise with the plaster shears to Guy's House-officers before breakfast, undoubtedly saved many limbs.

Pressure-sores

Pressure-sores occasionally develop over bony prominences, or elsewhere if the plaster cracks at a joint or if fingers or thumbs are pressed into the plaster as it is applied. It cannot be too strongly emphasised that a plaster cast should be painless, and if the patient complains of

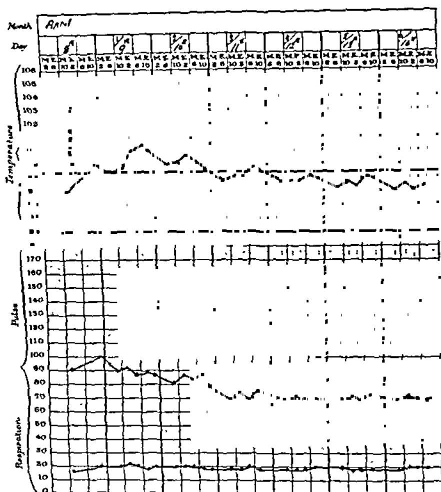


FIG 47.—Chart in a case of open fracture encased in plaster Note that the temperature has come down to normal in three days

pain the cause must be investigated, and it will probably be found to be due to a pressure-sore. Disappearance of pain is no indication that the danger no longer exists as these parts rapidly become anæsthetic. Other signs that a pressure-sore has developed are the appearances of discharge at the ends of the plaster (in a closed fracture), the seepage of discharges through the cast at the site of the sore and a local rise of

careful watch must be kept for the signs of imprisoned sepsis. I do not believe that a window cut over the site of the fracture is any help in the diagnosis of sepsis, and unless it is most firmly controlled by the application of dressings and a pressure-bandage, it gives rise to considerable trouble by the herniation of soft tissue through it. Furthermore, a window prevents that even pressure on the tissues upon which much of the success of the closed plaster method of treating infected wounds depends. Nevertheless, a window may be necessary for the introduction of penicillin as in any potentially infected wound (p 34). If the signs of imprisoned sepsis appear, then either the plaster must be removed, or a window should be cut over the site of the fracture and the wound laid widely open and dusted with penicillin powder or treated by penicillin instillations, but in no circumstances can chemotherapy replace adequate surgery in an infected wound that is not freely draining. A plaster may be somewhat uncomfortable at first, but it should never be painful even when the patient has an open fracture. Furthermore, the temperature, which may rise to 101° F. or more during the first forty-eight hours, should have settled in three days (Fig. 47). A continued pyrexia or a pyrexia appearing after the first few days, especially if accompanied by pain, a furred tongue, or other signs of uneasiness in the patient, should be an indication for removal of the plaster over the wound or even removal of the whole plaster My own preference is to remove the whole plaster, open up the wound, treat it according to the principles established for an infected wound and apply a fresh cast. However, with a very troublesome fracture, when it is thought that the satisfactory position of the bones will be disturbed by so doing, and this position may not be regained, then it will be safer to cut a window. If a window is cut and the wound operated on through the window all the troubles of flesh herniation may arise and the greatest care will have to be taken in packing the wound firmly and applying a pressure-bandage. In these circumstances the wound must be dressed as infrequently as the discharges allow, but even then the disturbance to the granulations is greater than if the part is completely encased.

Patients with infected open fractures discharging into a plaster cast should be nursed if possible in the open air; sulphonamide powder and lactose or a filter-cloth bag (p. 39) is applied, the latter after four days, to control the smell. If an open fracture is granulating smoothly, the colour of the blood-staining on the plaster goes through the same changes as a bruise—red, rusty, maroon, brown and yellow. The plaster is changed in three weeks when the œdema has subsided and thereafter when the discharges make this necessary.

the third gives a sense of security which is quite unjustifiable. Either a fracture has united, in which case it is better left unprotected, or it has not united and it must be properly immobilised.

Movements

To return to our second principle of after-treatment, that all adjacent joints not immobilised must be actively moved from the start.

As a rule the joints above and below the fractured bones are immobilised, but this is a rule which can be transgressed if the fracture is at the end of a long bone, such as in a Colles' fracture, where it is not usually necessary to immobilise the elbow, and in a Pott's fracture of the ankle-joint, where the knee is not generally included in the plaster. Where, however, it is necessary to immobilise two joints, the muscles acting on those joints need never be allowed to waste from disuse. Thus, if both wrist and elbow-joint are immobilised for a fracture of the radius and ulna, flexion of the fingers will cause reflex synergistic contraction of the extensors of the wrist, although the wrist itself cannot move. Conversely extension of the fingers causes the flexors of the wrist actively to contract. Similarly movements of the shoulder cause contractions of the biceps and triceps muscles, the long heads of which are inserted into the scapula. All these muscles therefore which primarily act upon the immobilised wrist and elbow-joint can be made to function actively even while the patient is in plaster, so that, as soon as this is removed, power and freedom of movement are quickly regained. It is not sufficient for the surgeon to tell the patient to move his free joints and leave it at that. He must see that the patient puts the joints in question through a complete range of movement at least once a day. Thus with the wrist and elbow in plaster each interphalangeal joint and metacarpo-phalangeal joint of each finger and thumb must be completely flexed and completely extended. This can be done in the case of the fingers by touching first the distal palmar pad and then the base of the thenar eminence with each finger in turn. After which the finger is fully extended. In the case of the thumb this should first be extended, the base of the index finger is then touched to flex the interphalangeal joint and an attempt made to touch the base of the little finger to flex the metacarpo-phalangeal joint. Finally the thumb is completely extended. These movements are first of all undertaken by each finger separately and then by all the fingers working together, when the little finger, finding no room in the thenar eminence, will come to lie on the hypothenar eminence. Gentle auto-passive movements may be allowed to assist and encourage the active movements, but in no sense to take their place.

temperature of the cast at this site. These are indications for the making of a window and for treating the pressure-sore as discussed on p. 270.

Internal Fixation

If a fracture has been plated or grafted, then exactly the same degree of immobilisation is carried out for just as long as if no form of internal fixation had been used. *The introduction of new plating materials, supposedly inert, makes no difference to this principle.*

Removal of the Plaster

The plaster is kept on, with as many changes as are necessary, until the fracture has united. No time limits can be laid down for the removal of the casts in any particular fracture, but a third post-operative X-ray photograph is taken at about the time when the fracture may be expected to have healed. Thus in Colles' fracture after four weeks; in Pott's fracture after eight weeks; in fractures of the shafts of the radius and ulna or tibia and fibula in ten weeks (a longer period than is commonly recommended). For this X-ray photograph clear definition is required, and it must therefore be taken when the plaster cast has been removed. If the signs of union are unsatisfactory a fresh cast is applied. A plaster is finally discarded when attempts to "re-break" the bone are unaccompanied by pain, when there is no local tenderness or œdema and usually when the X-rays show bony trabeculæ (not just calcifying callus) passing across the line of the fracture. Exception to this last rule may be made in fractures of the phalanges, metacarpals and metatarsals where radiological union is delayed long after clinical union. The immobilising apparatus may similarly be removed in fractures of the jaws without waiting for radiological union. If the signs are equivocal, then the complete cast must be reapplied. At the stage before final union, decalcification is still possible and to prevent this the fragments must still be completely immobilised. As the original cast was the least possible that would ensure absolute immobilisation, then this must be repeated. There is a dangerous tendency at this stage to apply a shorter plaster on the grounds that the fracture has very nearly healed and just needs protection. Thus in fractures of the radius and ulna a below-the-elbow plaster is put on, in fractures of the shafts of the tibia and fibula a below-the-knee plaster and in fractures of the spine a spinal support. None of these devices immobilises the site of the fracture or saves it from shearing strain, and all are to be condemned. The first allows pronation and supination to take place, the second has no control over rotation of the foot with the lower fragment on the upper fragment and



(*a*) Household duties



(*b*) Typing

FIG 48.—Activity in plaster.

The shoulder-joint is likewise put through a full range of movement each day. *Such is the minimum requirement. In addition to these* regulated exercises the patient must be encouraged to use the fingers and the arm as far as possible in carrying out his everyday work. In a below-the-elbow plaster for a Colles' fracture, a housewife can and should use the hand in her housework (Fig. 48). Persuasion may be required and the untutored criticism of relatives may have to be surmounted, but it should be explained to the patient that the broken bones are firmly held by the plaster, and that no damage and only good can come from active use of the unencumbered parts.

When the knee and ankle are immobilised in plaster, active exercises of the toes are instituted at once. The toes are flexed and extended together and a platform of plaster projecting beyond them may be used for the toes to press against. Quadriceps exercises are even more important. With the patient lying on his back the plastered limb is lifted up by the surgeon. The patient is then instructed to hold it in this position. At first this may be impossible, but he will, sometimes quite suddenly, acquire the knack and thereafter will be able to raise the leg off the bed himself. As soon as this can be performed, a sandbag is tied on to the plaster at the ankle to increase the weight, and by the end of a week the patient should be able to support the weight of a flat-iron suspended from the ankle-joint and to flex and extend the hip against this resistance. In plasters going above the knee, this joint is put up in 15° of flexion in order to control rotation of the foot and prevent stiffness of the knee. Consequently walking is rarely possible and these exercises are relied upon, sometimes for many months, to prevent the quadriceps from wasting and they should be performed for five minutes every hour. In below-knee plasters walking can often be started as soon as the plaster has set and in such cases no other exercise is necessary. If, however, the plaster has been put on after œdema has appeared, so that as the œdema subsides the plaster becomes loose, then it may not be possible to start walking until a fresh plaster is applied in three weeks. In these circumstances the above exercises are used, and in addition the knee is flexed and extended with the thigh flexed vertically, and with the patient lying on his back the legs are made to go through the motions of bicycling.

In fractures of the spine immobilised in a plaster jacket, twice each day for five minutes the patient lies on his face and by raising the head and neck off the couch and thrusting his arms with extended fingers forcibly down over the buttock the small muscles of the upper part of the back are made to contract The sides of the bed or couch are then gripped at the level of the head and first one and then the other thigh



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FIG 48.—Activity in plaster.

is extended with the leg straight. At first the leverage of the extended leg may be too much and by flexing the knee to a right-angle this is considerably reduced. Eventually the patient should be able to extend both thighs together with the legs held out straight. Again the importance of carrying on with the normal life is stressed. The patient with a crush fracture of a vertebra, immobilised in a plaster jacket, can usually get up and walk about soon after the plaster has set.

After the nailing of an intracapsular fracture of the neck of the femur, the patient is allowed the freedom of the bed. In fractures high up in the neck (subcapital fractures), it may be necessary to prevent the foot falling into external rotation whilst the patient is lying on his back by wearing a shoe across the heel of which has been nailed a board a foot long. This appliance restricts his movements to a certain extent, and it should be discarded after fourteen days. If, however, this "boarded shoe" is deemed necessary, it should be removed twice each day while the patient turns on to his sound side and flexes the knee. After three or four days flexion and extension of the hip is combined with the knee movements, and in a week to ten days the heel should be able to touch the buttock with the hip flexed to a right-angle. No passive or auto-passive movements are allowed, but massage and faradism should be given to the quadriceps and calf muscles. Particular care must be taken to prevent "drop foot" by means of a cradle to support the weight of the bedclothes and by active exercises to the ankle-joint. The board and shoe used to prevent rotation will also serve to prevent "drop foot".

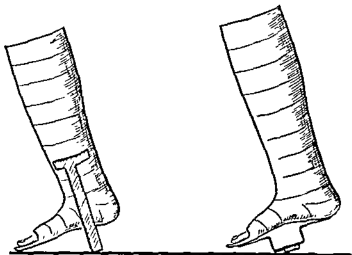


FIG 49—Showing how the more anteriorly placed iron protects the fore-part of the plaster sole, which is kept clear of the ground in walking

WALKING APPLIANCES

Walking in a below-the-knee plaster is facilitated by applying an extension to the sole of the plaster. This extension serves two pur-

poses: first, to raise the plaster off the ground and prevent it from being broken, and second, to allow the foot to rock so that a more or less normal gait can be employed with the stiff ankle-joint and without resort to rotation. Many devices have been proposed for this purpose, and as a result of an extensive trial with all of these the following conclusions have been reached. All forms of extension which project directly downwards in line with the tibia and fibula so as to give support below the heel are unsuitable because this support is too far back. The proportion of the foot in front of the support being relatively long, the fore-foot is slapped down on to the ground with each step forward (Fig. 49) and this part of the plaster rapidly becomes broken up. To avoid this the extension must be unsuitably long and this gives rise to a very awkward gait with the knee permanently bent. Further, when the support is directly below the line of the tibia and fibula, the tendency to rotate the foot outward with each step is almost irresistible, for the support coming at the centre of rotation, there is nothing to counteract it. This difficulty makes all patterns of walking-stirrup or heel attached in the line of the tibia and fibula unsuitable and these methods should be discarded in favour of one of the following.



FIG 50a—The "motor-tyre" walking appliance.

(1) '*Sorbo*' *sponge* applied to the sole by strapping. This method is very simple and gives a pleasant spring to the gait. The sorbo can be applied under the instep and the requisite height is obtained by the

previous application of a block of plaster 1½ to 2 inches deep to the sole of the plaster when this was first put on. The disadvantage is that the strapping soon wears out and the sorbo must be constantly readjusted. It is not suitable for hospital out-patients or Service patients unless they can receive constant attention.

(2) *The "Motor-Tyre"* (Fig. 50*a*)

This method, devised by E. R. Davies (*Guy's Hospital Gazette*, 1940, 54, 220), has many advantages. The apparatus is made from an old motor-tyre which has holes cut in it for the laces. It can be applied to the correct part of the foot and imparts a certain spring to the gait with the absorption of shocks. Its disadvantage is that in order to achieve the desired height for rocking, a fairly deep block of plaster must have been applied previously, otherwise the patient rotates rather than rocks, and this block of plaster together with the bulky tyre makes the apparatus somewhat cumbersome and heavy. The materials for its manufacture are, however, always available, it is cheap and it can be discarded at night. Of all the improvised methods this is probably the best.

(3) *The "Guy's Sole"* (Fig. 50*b*)

This apparatus, designed by Mr. Richards of the orthopædic workshop of Guy's Hospital, consists of a metal plate, angulated as shown in the figure and incorporated in the sole of the plaster, either at the time when this is originally put on or later. A rubber heel or strip attached to the projecting bar makes for comfort and the absorption of shock. The projection is arranged to fall beneath the instep so that rocking is encouraged. The apparatus is light and being incorporated in the plaster gives a sense of security which is lacking in the above methods.



FIG 50*b*—The "Guy's Sole" This is made from a 2 in by $\frac{3}{16}$ in iron strip with a 2 in rubber heel fixed to the bottom with a $\frac{3}{16}$ in countersunk, headed nut and bolt The cost is metal *3d*, rubber heel *3d* per pair, nut and bolt 1*d* Time to make a quarter of an hour The plate may be perforated with holes ¼ in. in diameter, this allows the plaster to take a better hold and renders the sole more secure

(4) *The Rocking Hoop*

The London Splint Company have produced a walking appliance consisting of two parallel metal bars bent to form a regular curve roughly semi-circular in shape. These parallel bars are fitted at one end to the back of the plaster above the heel and, sweeping round behind and below the heel, are attached at the other end to the fore-part of the sole. In stepping forward the weight is borne progressively more anteriorly as the " hoop " rolls over the ground, thus protecting the front part of the sole of the plaster and reproducing the distribution of weight in natural walking. The apparatus is somewhat expensive for routine hospital use and a satisfactory substitute can be manufactured by opening out an " ordinary " walking-stirrup, beating the metal into a semi-circle and applying one limb of the stirrup to the back of the leg and the other to the sole of the foot as described above. The space between the hoop and the plaster cast is filled in with fresh plaster and, if the curve of the hoop is carefully adjusted and projects for the correct distance (1½ inches maximum) below the sole, this appliance gives the most satisfactory results.

III. IMMOBILISATION IN DISTRACTION

General Principles

There is a further method of immobilisation, however, and that is by means of distraction. This method, which is not so satisfactory in securing absolute immobility, has the advantage that it overcomes displacement and prevents angulation. In certain fractures, such as oblique fractures of the shaft of the tibia, where there is especial liability to displacement, it can be combined with plaster and discarded only when any tendency to overriding has been surmounted.

Extension, or as it is better termed—distraction, can be applied to a limb by means of a pull exerted on the surrounding soft tissues (*skin traction*) or by means of a stainless-steel wire or pin passed through a bone distal to the site of the fracture (*skeletal traction*). Whether to use skin traction or skeletal traction, and if the latter, whether to employ a wire or a pin and which bone to pass it through, are problems which concern the surgeon. For our present purpose we need only to understand the principles of distraction and how to deal with cases when the distraction apparatus has been set up. When skin traction is employed the strapping passes down the limb on either side to a " spreader " made of a square of wood with three-inch sides and a hole bored through the centre. This spreader serves to keep the strapping

previous application of a block of plaster 1½ to 2 inches deep to the sole of the plaster when this was first put on. The disadvantage is that the strapping soon wears out and the sorbo must be constantly readjusted. It is not suitable for hospital out-patients or Service patients unless they can receive constant attention.

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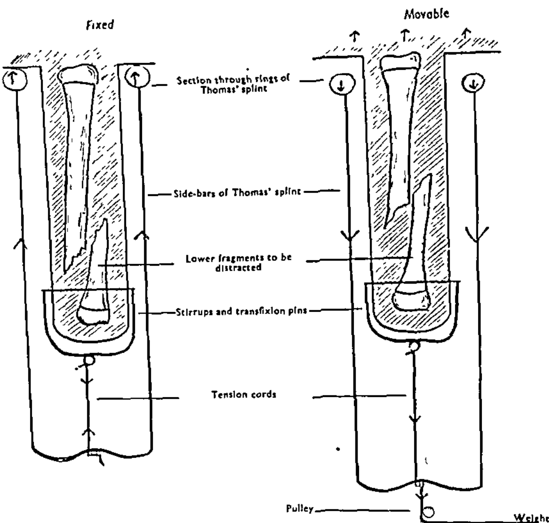


FIG 51 —Diagram to show the distribution of forces in "fixed" and "movable" distraction In fixed distraction counter-traction is supplied by the thrust of the ring of the Thomas' splint into the groin or axilla In movable distraction counter-traction is supplied by the weight of the body with the foot of the bed raised.

other respect is to be preferred to fixed distraction. The ring of the Thomas' splint need not be thrust home into the axilla or groin; in fact, this splint is used merely to support the limb and to steady the distraction cord, and the latter is always taut and a known amount of force can be applied.

Happily, it is generally possible to take advantage of the benefits of both methods, as the one is readily convertible to the other merely by thrusting the ring of the Thomas' splint firmly up into the groin and tying the distracting cord tightly to the opposite end or, conversely, untying the cord, withdrawing the ring of the Thomas' splint an inch or two and re-tying the distracting cord and attaching a weight to the

away from prominent bony points in the distal part of the limb, such as the tibial and fibular malleoli, which would otherwise bear the brunt of the distraction. These parts are further protected by placing felt pads on the sticky side of the strapping as it rides over them, or alternatively by attaching another piece of strapping to the extension strapping, sticky side to sticky side, so that only the back of the strapping comes into contact with the malleoli. A cord with a large knot at the end of it is threaded through the hole in the spreader and traction is applied through this cord.

When skeletal traction is used, the wire or pin is attached to a stirrup which is clear of all bony prominences and to which the traction cord is attached by means of a hook. In this case it is necessary to see that the points of entry and exit of the wire or pin in the skin are well protected by gauze soaked in collodion. When eventually skeletal traction is discarded, the stirrup is removed, and if a wire has been used this is cut off flush with the skin on one side. A gauze sponge soaked in iodine is now placed over the wound on that side or, in the case of a pin, is wrapped round the projecting part and left for half an hour. The wire or pin can now be withdrawn from the opposite side and the two holes are sealed with a collodion dressing. A low-grade osteomyelitis occasionally complicates the passage of wires and pins and causes a long-continued discharge from a sinus leading down to bone. This usually clears up spontaneously and, if the wire has been correctly placed, does not give rise to any stiffness in the adjacent joint. Anything more than a trivial infection will call for the immobilisation of the part in plaster.

There are two main principles of distraction—" fixed " distraction and " movable " distraction. The accompanying diagrams (Fig. 51) will demonstrate the principles.

Fixed distraction has the advantage that the patient is movable, and can be transported by ambulance or train with the apparatus still functioning. It has, however, serious drawbacks. In the first place the constant pressure of the ring of the Thomas' splint in the groin or axilla eventually gives rise to soreness; the traction cord is drawn tight, but unless a spring-balance were inserted into it—and this would be impracticable—there is no telling how tight and consequently the amount of distracting force being applied to the bone is unknown; and lastly the distracting cord requires constant attention, otherwise it exerts no pull at all The use of a " Spanish windlass " is the best method of ensuring continuous traction.

Movable distraction requires a " Balkan beam " or other cumbersome apparatus and the patient cannot be moved about, but in every

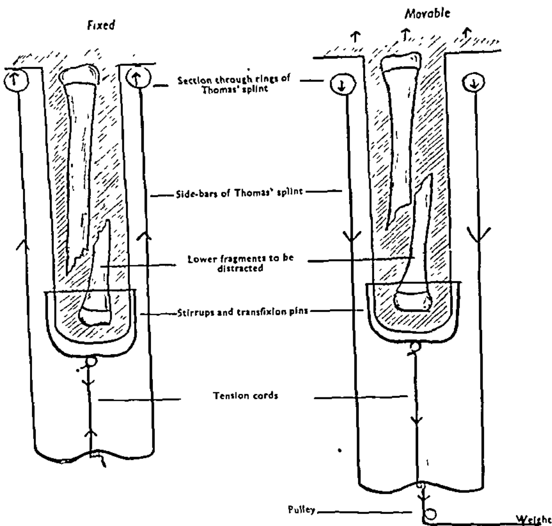


FIG 51 —Diagram to show the distribution of forces in "fixed" and "movable" distraction In fixed distraction counter-traction is supplied by the thrust of the ring of the Thomas' splint into the groin or axilla. In movable distraction counter-traction is supplied by the weight of the body with the foot of the bed raised

other respect is to be preferred to fixed distraction. The ring of the Thomas' splint need not be thrust home into the axilla or groin; in fact, this splint is used merely to support the limb and to steady the distraction cord, and the latter is always taut and a known amount of force can be applied.

Happily, it is generally possible to take advantage of the benefits of both methods, as the one is readily convertible to the other merely by thrusting the ring of the Thomas' splint firmly up into the groin and tying the distracting cord tightly to the opposite end or, conversely, untying the cord, withdrawing the ring of the Thomas' splint an inch or two and re-tying the distracting cord and attaching a weight to the

fall. Thus, if a wire has been passed through the tibia in the theatre, fixed distraction is set up and the patient taken to his bed where it is converted into movable distraction. If it becomes necessary to evacuate such a patient, the apparatus is readily converted once more into fixed distraction, and the patient can be transported by ambulance or train.

Maintenance

Just as in plaster so in distraction, constant attention is required The patient must not be left "to rot", as one of my colleagues so aptly puts it, "a bag of bones in the bed". As we have seen, a fixed distraction apparatus requires almost hourly attention to see that the distracting cord is taut and to prevent sores from developing in the groin or axilla. Movable distraction should be thoroughly inspected each day. The apparatus is like the rigging of a ship, and like this rigging it must be examined daily throughout the voyage for chafe, to see that the blocks are running freely, that pulls are being exerted in the proper direction and that shifting of the cargo has not produced uncompensated strains. To relinquish our metaphor, we must see that the foot is at right-angles to the leg, that it is not rotated outwards, that the sides of the Thomas' splint are not pressing on the flesh and that each sling is supporting its proper weight.

Movements and Physiotherapy

Active exercises are of the first importance in the lower limb, the toes and ankle being moved through their full range twice daily. The patient practises rendering his quadriceps taut so as to fix the patella and this exercise may be undertaken periodically throughout the day. In addition, as the parts are exposed, massage may be given to the whole limb and faradic stimulation to the quadriceps group. Passive exercises to the ankle-joint should have no place in the treatment and the patient must be urged to move this joint by himself. We have seen that while at rest the foot is maintained at right-angles to the leg. This is sometimes done by a bracket fixed at right-angles to the leg-piece of the splint up against which the foot rests. If this method is used the webbing on the foot-piece must be removed at least three times daily for ten minutes so that active exercises of the ankle-joint may be practised A better method is to dispense with a foot-piece and apply strapping to the sole of the foot; this strapping is connected to a cord which runs over a pulley, so placed on the Balkan beam that when the cord is taut the foot is held at right-angles to the leg. To the other end of the cord is attached a weight of one to two

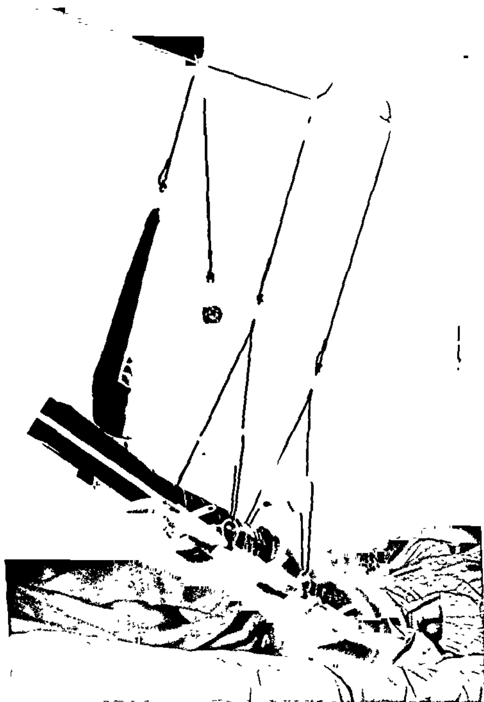


Fig 52.—Method of preventing "foot drop" while in a distraction apparatus which allows exercise of the ankle-joint.

pounds, so that by exercising the ankle-joint the weight is raised and lowered (Fig. 52). If the skeletal traction has been passed through the lower end of the femur, then the knee is exercised from the first. The leg is supported as usual in a cradle attached to the Thomas' splint (Fig. 53) and angulated so that the knee is in about 15° of flexion, but in this instance the cradle is articulated with the bars of the splint, so that by adopting the following plan the leg can be flexed and extended while still in the cradle. A cord is attached to the foot-piece of the cradle and led over pulleys to a handle above the patient's head. By pulling on the handle the leg is extended and by releasing the handle the leg falls into flexion by virtue of its own weight. This method of applying auto-passive movements to the knee-joint can be practised from the first few days, and should serve only to assist the patient in his attempts to contract the quadriceps. As soon as he has acquired the knack of this, the leg is released from the cradle four times each day, and for five minutes the patient flexes and extends the knee without help.

In the upper limb the fingers, thumb and wrist-joint are similarly actively exercised, making sure that the extreme range of movement

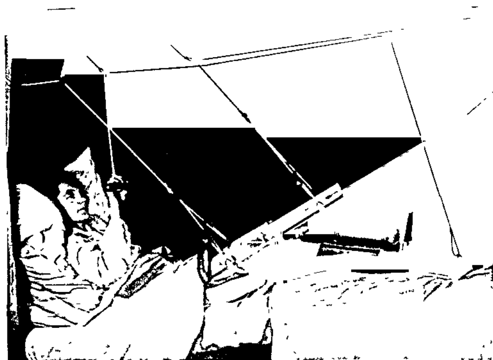


FIG 53 —Apparatus for auto-passive movements of the knee-joint whilst the femur is being distracted Arrow points to the butterfly-screw attachment

is attained in each case. Massage and faradism may help to keep up the tone of the biceps and triceps muscles.

The Distracting Force

The weight to be used in a distraction apparatus is a matter which must be decided in each case by the circumstances. These circumstances are the *age*, *sex* and *build* of the patient, the *bone* to be distracted and the *degree of overlap*, so that no definite rules can be laid down. One general principle, however, must be observed, and that is to put on the *maximum weight* likely to be required *at once*. During the first twenty-four hours overlap is most likely to be overcome, whereas after this time it may be necessary to manipulate the fracture under an anæsthetic, using considerable force to reduce the overlap. Furthermore, overdistraction can readily be avoided by reducing the weight. As a rough guide, between thirty to forty pounds are required for a fractured femur of an adult male and between twenty to thirty pounds for an adult female. A fractured tibia and fibula require about fifteen to twenty-five pounds for an adult male and ten to twenty pounds for an adult female. Children of twelve to fifteen years require a half to two-thirds the weight of distraction that would be necessary for an adult in similar circumstances. For fractures of the humerus the weight of the dependent elbow with the arm suspended in a collar and cuff is usually sufficient. In this fracture great care must be taken to

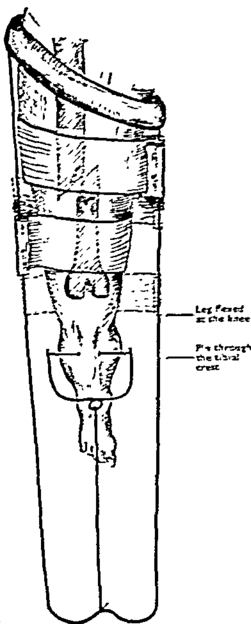


FIG. 54.—Reduction of lateral displacement while the fracture is distracted in a Thomas' splint. Position of supporting slings is indicated by dotted bands.

avoid over-distraction, and as soon as overlap is reduced any further distraction must be discontinued.

X-ray photographs are taken frequently during the first ten days to observe the effect of the distraction in reducing the overlap. In the case of the femur, as soon as reduction has been satisfactorily effected, the weight is reduced to about ten pounds (in adults), so that the fragments are held steady.

Lateral displacements may be corrected during the course of distraction by pulling on the fragments in the required direction by means of flannelette bandages fastened to the bars of the Thomas' splint by heavy paper-clips or safety-pins (Fig. 54). Some forms of special apparatus have been devised for exerting pressure on fragments displaced laterally and these are quite satisfactory. As in the case of plaster so in distraction, this is maintained until the fracture has united. Angulation of a fractured femur may be corrected as described on p. 223.

IV. COMPLICATIONS

Delayed Union and Non-union

Conventionally a fracture which has not united in six months is said to be subject to delayed union and a fracture which has not united in a year to non-union. Time limits of this sort are, however, as inappropriate here as they are in deciding when to remove a plaster or a distraction apparatus. Any fracture in which the normal processes of calcification and ossification are not observable in the X-ray film may be said to be subject to delayed union and any fracture with sclerosed bone-ends is subject to non-union.

Delayed union and non-union may be due to factors outside the control of the surgeon, such as avascular necrosis discussed below, but they are almost invariably due to one of two causes—imperfect reduction or inadequate immobilisation. The problems of reduction do not concern us here, but perfect immobilisation is one of the two principal concerns of after-treatment. This problem has been discussed fully above, and it is only necessary to repeat the warning against using below-knee plasters in fractures of the tibia and fibula, and spinal supports in fractures of the spine at any time during the treatment, on the mistaken assumption that these measures will serve to " protect " an imperfectly united fracture. In cases of delayed union complete immobilisation must be kept up and in the end, provided it has been properly reduced, the fracture will unite. Non-union demands an open

operation for the removal of the sclerosed bone-ends at the very least and the case is then treated as a new fracture.

Mal-union

Mal-union, or the union of a fracture in an unsatisfactory position, should never occur if X-ray pictures are taken immediatley after reduction and immobilisation, and again after a fortnight. Up to this time mal-alignment can be satisfactorily adjusted by *manipulation under an anæsthetic.* After a month, in many fractures, manipulation may be impossible, although in some open fractures delay in union may be so prolonged that a mal-alignment can be adjusted by manipulation after many months.

If the fracture appears firmly united, then in a Colles' or Pott's fracture up till about five weeks from the date of injury an attempt may be made to *re-break the bone over an orthopædic wedge* under an anæsthetic. If this is successful, the bone may be reset and immobilised. If union is too firm to allow this, then a *reconstruction operation* must be performed. The details of this do not concern us here, but the principle is to reproduce the fracture with an osteotome and to reset and immobilise. Reconstruction operations are usually possible up to a year from the time of the receipt of the injury. They are designed to prevent the osteoarthritis and disability consequent on mal-alignment. After this time adaptive changes have probably taken place in the joints, and the operation, far from succeeding in its object, may in fact accelerate the appearance of the secondary degenerative joint changes.

Avascular Necrosis

Occasionally a bone is fractured so that one fragment is completely, or to a very great extent, cut off from its blood-supply. Revascularisation of this fragment then depends upon the growth of delicate capillaries thrusting through the granulation tissue bridging the gap and, unless immobilisation is perfect and prolonged, these capillaries are ruptured and the fragment dies. Two sites are especially prone to this complication—the head of the femur in subcapital fractures and the proximal fragment of the carpal scaphoid in fractures through the waist of this bone. The head of the femur derives its blood-supply from two sources, one reaching it via the vessels in the capsule of the hip-joint through the neck and an inadequate supply from the vessels in the ligamentum teres (Fig. 55). Intracapsular fractures through the neck of the femur, proximal to the point of entry of the capsular vessels, cut off the proximal fragment from all but the vessels from the ligamentum teres. The method of treating these fractures with the Smith-Petersen

avoid over-distraction, and as soon as overlap is reduced any further distraction must be discontinued.

X-ray photographs are taken frequently during the first ten days to observe the effect of the distraction in reducing the overlap. In the case of the femur, as soon as reduction has been satisfactorily effected, the weight is reduced to about ten pounds (in adults), so that the fragments are held steady.

Lateral displacements may be corrected during the course of distraction by pulling on the fragments in the required direction by means of flannelette bandages fastened to the bars of the Thomas' splint by heavy paper-clips or safety-pins (Fig. 54). Some forms of special apparatus have been devised for exerting pressure on fragments displaced laterally and these are quite satisfactory. As in the case of plaster so in distraction, this is maintained until the fracture has united. Angulation of a fractured femur may be corrected as described on p. 223.

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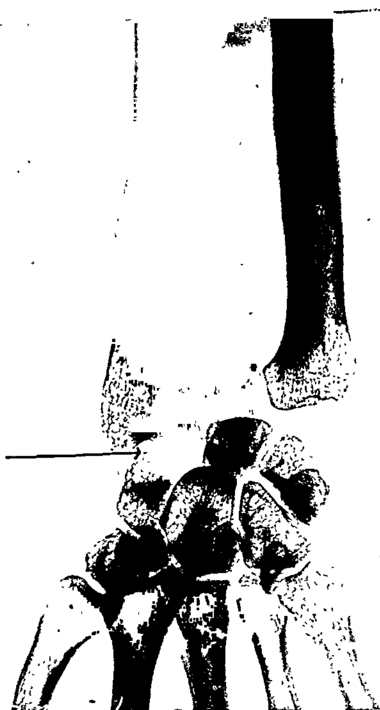


FIG. 56 —Avascular necrosis of medial fragment in a fracture of the carpal scaphoid.



FIG. 56 —Avascular necrosis of medial fragment in a fracture of the carpal scaphoid.

nail usually immobilises the fragments sufficiently to allow the capillaries from the main fragment to grow across the gap and revascularise the head. Sometimes, however, this process proves inadequate and the head undergoes avascular necrosis. Similarly in the carpal scaphoid, the blood-supply in 50 per cent. of cases reaches the bone by nutrient arteries penetrating only the distal half, the proximal half deriving its blood-supply from vessels coursing through the bone. Accordingly a fracture of the waist will in these cases cut off the proximal half completely from its blood-supply, and the most

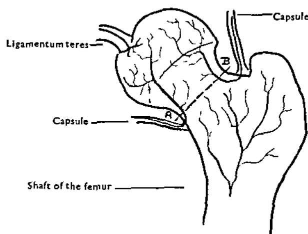


FIG 55 —The blood-supply to the head of the femur showing how a fracture through the line AB cuts off the head from all but the small vessels reaching it through the ligamentum teres.

careful immobilisation of the wrist-joint may not prevent avascular necrosis appearing in the proximal half of the bone.

In the first of these fractures walking is never permitted before eight weeks and in the second the wrist is immobilised in plaster for at least eight weeks. By this time we are in a position to be able to diagnose avascular necrosis radiologically by the sclerosis of the affected bone, and if it exists, then it means that no weight-bearing must be allowed in the case of the fractured femur for a further period of some months, and the fractured scaphoid must be kept in plaster for a similar period until the radiological evidences of avascular necrosis have disappeared, indicating that the fragment has become revascularised and the fracture has completely united by bone. If after six months in the case of the fractured femur and a year of immobilisation in the case of the fractured scaphoid radiological evidence of avascularity persists, then operative intervention is called for. What are the pathological processes which bring about the radiological signs of avascular necrosis? As a result of injury the

the muscles, are pain, blueness, coldness and stiffness of the hand and fingers, a feeble return of capillary blood on blanching the fingers by pressure, disappearance of the radial pulse, the fingers are held flexed and there is pain on attempting to extend them. After a variable interval the radial pulse returns and the signs subside. In from four to six weeks the fingers begin to curl up, and it is found that they will not extend until the wrist-joint is flexed. This abnormality is due to necrosis and fibrosis of the flexor muscles of the fore-arm. As the child grows, the bones of the fore-arm lengthen, but the dead fibrosed muscles do not grow, and as a result the deformity progresses, and in severe cases the arm becomes useless. Treatment must be instituted at once to forestall this gloomy train of events. As soon as the vascular signs appear in the hand or fingers, the fracture, if not already reduced, must be set and the elbow immobilised in 80°–90° flexion and a dorsal plaster slab is applied. If the fracture has been already satisfactorily reduced, then all constricting appliances are removed and the elbow-joint, which will probably have been put up in about 60° flexion, is allowed to extend by 20°–30°. If the circulation is not restored in thirty minutes, the arm is allowed to take up the most comfortable position without regard to its effect on the fracture, and this is usually about 120° of flexion. If in a further hour the circulation is still inadequate, an incision is made through the deep fascia in front of the elbow-joint and the artery is exposed. Methods of treating this condition by peri-arterial sympathectomy, stellate ganglionectomy or arteriectomy are still under discussion. Following these measures or, if a case is seen where the prodromal warnings have been ignored and Volkmann's ischæmic contracture is to be expected, the hand and fore-arm are placed on a splint with the fingers and wrist extended. The splint is removed three times a day for ten minutes so that the fingers and wrist may engage in active exercises through their full range of movement. For the established condition operative interference is necessary, but the prognosis for function is very poor.

Nerve Lesions

Damage to peripheral nerves is discussed on p. 274, but in connection with fractures there are some particular problems to be considered. Nerve lesions following fracture are of three types: immediate, where the nerve is injured at the time of the accident; intermediate, where the nerve suffers from neuritis; and late, where the nerve has been subject to distortion for many years due to mal-union of the fracture. Again supracondylar fracture of the humerus may be taken as an example to illustrate the principles of these lesions. After

blood-vessels in the region dilate and the blood-supply to the part is increased. Because of this increased blood-supply calcium is washed away and the bone undergoes rarefaction. The avascular fragment, however, being cut off from its blood-supply, is similarly cut off from these changes in the calcium-content of the surrounding bones and therefore fails to rarefy with these. Consequently the avascular fragment appears relatively dense compared with the surrounding bones (Fig. 56). This relative density is apparent only when the surrounding bones have become decalcified, and as this process takes about eight weeks, it is not until this time that the condition can be diagnosed. If X-ray examination is delayed much beyond this interval of time, the sclerotic fragment may have begun to revascularise and the sclerosis may not be sufficiently marked for the radiologist to be able to say if such a process had occurred. Walking or mobility may therefore be started too early, with disastrous consequences to the hip or wrist-joint. Avascular necrosis is a potent source of delayed union and non-union, and the cardinal principles of treatment are absence of weight-bearing and complete immobilisation until union is sound.

Vascular Lesions

Apart from the disturbance of blood-supply due to an improperly applied plaster cast, the blood-vessels of a limb may sustain damage at the time of the original injury. Vascular disturbances of this sort are most common after supracondylar fractures of the humerus in children, and this fracture will therefore serve as an example to illustrate the general principle. An artery may be damaged by pressure from a fragment of bone, and as a result vascular abnormalities will be apparent at once. Sometimes the outer coats of the vessel are damaged, the weakened wall gives way and a traumatic aneurysm forms. Sometimes the artery sustains damage to the intimal coat, and this may lead to rapid thrombosis with gangrene or, more rarely, to isolated mural thrombi which later become detached and give rise to embolic manifestations distally. The commonest cause of vascular abnormality is intense spasm of the vessel in the region of the fracture which, by cutting off the blood-supply to the muscles, produces irreversible changes in these and leads to the condition known as "Volkmann's ischæmic contracture". The pathology of this spasm is still a matter for conjecture. We know that this condition comes on usually within a few hours of the injury and that it most commonly complicates a supracondylar fracture of the humerus. The signs of this condition, which must be treated with the greatest urgency in order to prevent the irremediable and utterly crippling changes which supervene in

(Fig. 57), and the periosteum is torn off from the front of this bone. If the fracture is set satisfactorily at the first attempt under a general anæsthetic, and if passive movements are absolutely disallowed, this lesion resolves spontaneously and no embarrassing new bone is formed

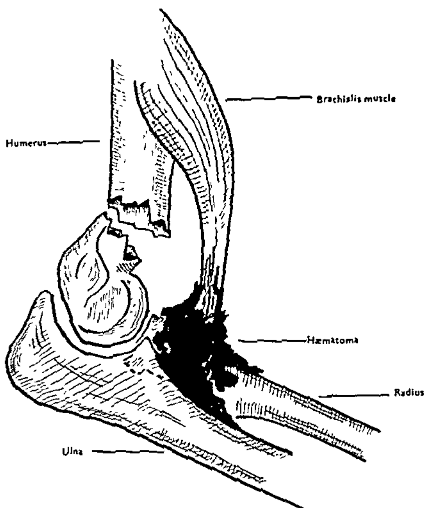


FIG 57.—The formation of a sub-periosteal hæmatoma.

in front of the elbow-joint. If, however, forcible and injudicious attempts are made to reduce an already swollen elbow or if later any attempts at passive movement or stretching of the joint by carrying heavy weights is allowed, then the added insult serves to tear the periosteum still further. Fresh hæmatomata form which ossify, producing eventually bars or blocks of bone which limit the flexion of the elbow-joint, sometimes to a crippling degree. The sort of case where ossifying hæmatoma may be expected is in a supracondylar

this fracture the ulnar is the nerve most usually damaged and the signs of ulnar nerve palsy appear in the hand.

The nerve may be injured at the time the bone was broken; it may, in fact, be penetrated by one of the fragments. With a reduction of the fracture the penetrating bone is withdrawn and the patient is left with the nerve palsy. Treatment for this is on the lines discussed on p. 274, and if the palsy has not recovered in six months, open operation is required to free the nerve, to unite a divided nerve or to excise a fibrosed segment and unite the remaining parts.

As a result of immobilisation after a supracondylar fracture the ulnar nerve may become anchored by organising traumatic exudate to its groove behind the medial epicondyle. When movements are begun in about six weeks, the nerve, which normally rides freely up and down in its groove on movements of the elbow, is unable to do so and is subjected to traction and drag. It is doubtful if active movements of the elbow-joint are ever able to produce ulnar neuritis in this way. Passive movements at this stage are absolutely contra-indicated in the elbow-joint both because of their liability to produce this condition and for even more urgent reasons which will be discussed below. Should tingling in the little and ring fingers or other signs of ulnar nerve irritation or palsy appear at the time of commencing movement in this joint, then the arm should be rested in a sling for a few days. Active movements may then be undertaken and the patient is warned not to indulge in auto-passive movements or to carry any object in that hand which by its weight might tend passively to extend the elbow-joint.

If a fracture about the elbow-joint produces an increase in the carrying-angle and the fracture is allowed to join with this mal-alignment uncorrected, the ulnar nerve will be stretched round the abducted elbow-joint. Symptoms usually do not arise for some ten years after such an injury, when tingling in the little and ring fingers and progressive weakness of the muscles supplied by the ulnar nerve call attention to the condition. The treatment is operative, and consists in transposing the nerve to the front of the elbow-joint. The prognosis, if the operation is undertaken early and before fibrosis has ruined the nerve permanently, is excellent

Ossifying Hæmatoma

This complication, which consists in ossification arising in the hæmatoma resulting from the tearing of muscles with their periosteal insertions away from the bone, is again common after supracondylar fractures of the humerus The backward displacement of the lower fragment causes the brachialis muscle to be detached from the ulna

(Fig. 57), and the periosteum is torn off from the front of this bone. If the fracture is set satisfactorily at the first attempt under a general anæsthetic, and if passive movements are absolutely disallowed, this lesion resolves spontaneously and no embarrassing new bone is formed

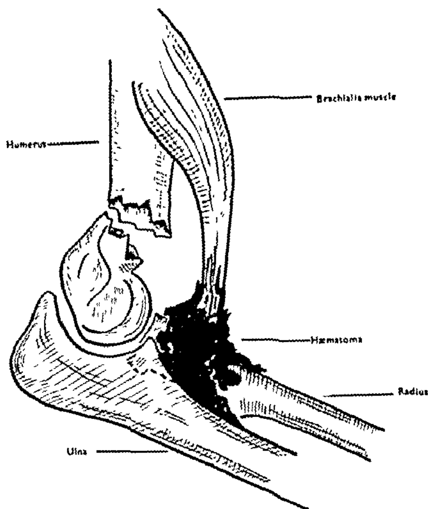


FIG 57 —The formation of a sub-periosteal hæmatoma

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fracture of the elbow occurring on the football field and " set " there and then by the captain of the opposing team whose brother is an osteopath. The case is then X-rayed in one of the more remote Cottage Hospitals, and a locum-tenens is called in to give gas and oxygen anæsthesia from an antiquated machine which he has never seen before, while the doctor makes a fresh attempt to reduce the fracture. By the time the case reaches a properly equipped centre, the elbow-joint and the tissues around are swollen to the size of a young Rugby football and the bony prominences are impalpable. Unless there is a vascular lesion, such a case should be left severely alone in the position it most readily takes up. The patient is put to bed, the arm elevated on a pillow and treated with compresses of lead and opium lotion. Only when the œdema has subsided, and then under full general anæsthesia, is a further attempt made at reduction. Any further manipulation at the time when the patient is first admitted to hospital will make the probability of the appearance of ossifying hæmatoma almost a certainty. The other type of case which develops this sort of complication is the elbow in which increase in range of movement is taking place very slowly, and in order to " accelerate " it, passive movements are prescribed or the patient is instructed to carry buckets of water, wear lead bracelets, or hang from the lintel of doors to increase the range of extension. Apart, however, from such errors in treatment, ossifying hæmatoma will sometimes complicate a case in which due precautions have been observed.

The signs of this complaint are firstly a diminishing range of movement, and then after some weeks the appearance of a diffuse shadow in the X-ray film; later a block or bar of fully-formed bone can be observed (Fig 58). After elbow-joint injuries, as soon as immobilisation is discarded, the range of movement of the joint is measured. Active exercises are given, but the patient is warned against trying to move the elbow with the other hand. Massage is unnecessary. Each week the range of movement is measured and this should show a progressive improvement. If progress is not maintained the elbow is rested in a sling for a week, while full movements of the fingers, wrist and shoulder continue. At the end of the week active movements only are resumed at the elbow-joint. The arrested progress indicates the earliest sign of ossifying hæmatoma, and if the above regime is adopted, the ossific process is held up and any ossific tissue which has formed is reabsorbed. When the condition is fully established and a bar or block of bone has formed which is causing severe limitation of movement, then, after an interval of at least a year from the time of original injury, and when the X-ray film shows that no further bone-



Fig 58 —Ossifying hæmatoma in the ante-cubital fossa.

fracture of the elbow occurring on the football field and "set" there and then by the captain of the opposing team whose brother is an osteopath. The case is then X-rayed in one of the more remote Cottage Hospitals, and a locum-tenens is called in to give gas and oxygen anæsthesia from an antiquated machine which he has never seen before, while the doctor makes a fresh attempt to reduce the fracture. By the time the case reaches a properly equipped centre, the elbow-joint and the tissues around are swollen to the size of a young Rugby football and the bony prominences are impalpable. Unless there is a vascular lesion, such a case should be left severely alone in the position it most readily takes up. The patient is put to bed, the arm elevated on a pillow and treated with compresses of lead and opium lotion. Only when the œdema has subsided, and then under full general anæsthesia, is a further attempt made at reduction. Any further manipulation at the time when the patient is first admitted to hospital will make the probability of the appearance of ossifying hæmatoma almost a certainty. The other type of case which develops this sort of complication is the elbow in which increase in range of movement is taking place very slowly, and in order to "accelerate" it, passive movements are prescribed or the patient is instructed to carry buckets of water, wear lead bracelets, or hang from the lintel of doors to increase the range of extension. Apart, however, from such errors in treatment, ossifying hæmatoma will sometimes complicate a case in which due precautions have been observed.

The signs of this complaint are firstly a diminishing range of movement, and then after some weeks the appearance of a diffuse shadow in the X-ray film; later a block or bar of fully-formed bone can be observed (Fig. 58). After elbow-joint injuries, as soon as immobilisation is discarded, the range of movement of the joint is measured. Active exercises are given, but the patient is warned against trying to move the elbow with the other hand. Massage is unnecessary. Each week the range of movement is measured and this should show a progressive improvement. If progress is not maintained the elbow is rested in a sling for a week, while full movements of the fingers, wrist and shoulder continue. At the end of the week active movements only are resumed at the elbow-joint. The arrested progress indicates the earliest sign of ossifying hæmatoma, and if the above regime is adopted, the ossific process is held up and any ossific tissue which has formed is reabsorbed. When the condition is fully established and a bar or block of bone has formed which is causing severe limitation of movement, then, after an interval of at least a year from the time of original injury, and when the X-ray film shows that no further bone-

his legs in the air. Flexion exercises are used on the spine and the patient should try to touch his toes with his knees braced back. When a patient with a fractured leg starts to walk for the first time without plaster, the tissues lose the support of the encircling cast and tend to become distended with œdema fluid. Before getting him on his feet a square of Elastoplast is stuck on the flexor aspect of the fore-arm; if no skin reaction appears, the leg is bandaged with Elastoplast from the metatarsal heads to the tibial tuberosity as soon as the plaster is removed, and this elastic support is worn for a fortnight. In some cases of open fracture of the tibia and fibula where the wound has granulated, the skin may not be fit to stand the irritating Elastoplast bandage, and in such cases Watson-Jones advises Unna's zinc gelatine paste. Cubes of the zinc gelatine are heated in a pot surrounded by boiling water until they melt. The resulting paste is tested with the finger to see that it is not too hot and applied to the leg from the metatarsal heads to the tibial tuberosity. A soft bandage is then put on and fresh layers of paste alternating with bandages are applied until the dressing is three or four layers thick. Alternatively, Ichthopaste bandages which have been immersed in hot water for ten minutes are suitable for a tender skin. These supports are worn for a fortnight.

Passive Movements

We now come to the vexed question of passive movements. Before discussing the indications for these it must be conceded that the doctor who prescribes passive movements is playing with a dangerous weapon, and he must understand its limitations and defects. It is far better to avoid passive movements altogether than to use them ill-advisedly. To understand the value of passive movements we must first discuss the quality of the so-called "accessory movements" of joints. Most joints, except the hip-joint which is a deep ball-and-socket joint, have two kinds of movements: "principal movements" which can be performed by the muscles acting on the joint and "accessory movements" which can be made only by the agency of an outside force. We have already outlined the accessory movements of certain joints, such as the metacarpo-phalangeal joint and the knee-joint. We saw that the former was capable of gliding, rotation and distraction, sometimes to a considerable degree, in addition to flexion and extension which are performed by the muscles controlling the joint. Similarly it was possible to move the flexed knee in an antero-posterior direction on the femur and also to rotate it and rock it from side to side (abduction and adduction). None of these movements, except a slight degree of rota-

formation is occurring, an operation is performed for removal of the bony block. Following this operation the elbow is rested in a sling for a fortnight and active movements are then started. The prognosis, as far as regaining full movements is concerned, is not good after this operation because, in addition to the bony block which is removed, there is almost certainly a severely limiting degree of fibrosis, which is not affected by the operation, and which maintains the stiffness of the joint.

Fat Embolism

After any severe injury, particularly if complicated by fracture of a long bone, the patient may succumb to fat embolism. Globules of liquid fat enter the veins and are carried to the pulmonary arterial tree whence they may escape through the capillaries into the systemic circulation.

After a latent period of about three days, the patient complains of pain in the chest with a productive cough, and develops cyanosis, dyspnœa and restlessness. Signs of consolidation appear in the lungs and there is fever. Following these manifestations, cerebral symptoms arise, first irritability then stupor without localising signs and with a normal cerebro-spinal fluid. The diagnosis may be confirmed by finding fat globules in the sputum. The only effective treatment is the administration of oxygen, if possible through a B.L.B. mask, but in an established case the prognosis is poor.

V. TREATMENT AFTER UNION

When the patient or limb first comes out of plaster or is released from the distraction apparatus, although the joints are slightly stiff and the muscles relatively weak, if the practice of exercising the adjacent joints has been conscientiously pursued, it is not long before complete freedom of movement returns and the tone of the flabby muscles is restored The key-note of treatment at this stage is active movement Massage and faradism may help to promote the circulation and give psychological encouragement, but it is active movement alone which will restore the parts to their full function. In the upper limb "physical jerks", which should be rather the steady controlled movements of the arm, are undertaken first with the empty hand and then with dumb-bells. In fractures of the lower limb the patient lies on his back, and with the legs extended raises and lowers one foot after the other in a scissor-like action and does " bicycling " exercises with

Post-traumatic Œdema

This complication, which is a most troublesome one to treat, should only very rarely arise if active movements have been employed from the first in the joints which have not been immobilised and if, in the lower limb, the part has been encased in Elastoplast or Unna's paste as soon as it was taken out of plaster. For the established condition, reapplication of Elastoplast may cause the œdema to subside, but if this is ineffective the Elastoplast will have to be taken off so that physiotherapy may be undertaken. Active movements are continued and the limb is elevated. Light massage may be effective and stimulation with the sinusoidal current often serves to get rid of the swelling. In cases completely resistant to treatment, an elastic stocking or crêpe bandage may have to be worn permanently.

Rehabilitation

For a discussion of this subject the reader is referred to Chapter XIV. At the Berry Hill Hall rehabilitation centre, a graphic record is kept of the power of the various muscle-groups in an injured limb as compared with those of the other side. According to their strength these muscles are given graduated exercises using increasing resistance. A syllabus of exercises is made out for each patient, who progresses from one stage of the syllabus to the next according to the records of his muscle-power. Together with these exercises the men work in the laundry, in the carpenter's workshop and in the garden, where finally tree-felling and log-sawing are undertaken. The nature of each man's regular work is carefully examined, and he is given occupational therapy which repeats the movements entailed in this work, but against a reduced resistance and with intervals of rest which he would not ordinarily be permitted. Games play an important part in rehabilitation, and arm and back cases play basket-ball. Leg cases cannot usually stand the strain of running games, particularly if a football is about, and these cases are supplied with bicycles from which they derive profitable recreation and enjoyment. In reading the accounts of these centres here and abroad, one cannot help being impressed by the enormous advantage to the patient of being surrounded by his fellow men. There is a feeling of co-operation and competition which encourages these patients to go one better than their neighbours, a state of affairs in which the private patient in his proud isolation is often sadly at a disadvantage.

tion, can be performed actively by the patient. These accessory movements give resilience to the joint and for its complete function they must be regained. The strains and stresses of everyday life will eventually cause the accessory movements to return, but function is regained far more rapidly if the accessory movements are made passively. Thus in the case of the fingers and the knee-joint passive movements directed towards regaining accessory movements may be prescribed with advantage. In the wrist, elbow and shoulder-joint, accessory movements are not so readily obtained, and in the instance of the elbow-joint can only be practised when full extension has been regained, by which time they will almost certainly be unnecessary. The hip-joint has no accessory movements, so that passive movements are never prescribed.

Manipulation

This manœuvre is the forcible moving of a joint in all its ranges, both principal and accessory, in order to break down adhesions and to increase movement. It is essential that the adhesions should have been stretched and rendered avascular by previous active movements, otherwise the tearing of these adhesions will only give rise to fresh effusion, and thus fresh adhesions when this effusion organises. There should be no hurry to manipulate a joint, and the full effect of active exercises should have been established before this measure is considered. An anæsthetic is given, not because the manipulation is painful—these avascular adhesions are insensitive—but in order to relax the muscles so that force is not expended in stretching or even tearing them. Only one adhesion, or one row of adhesions, is broken down at a time, in order to give the second row an opportunity to stretch as a result of the increased range of active movement that the first manipulation has occasioned. As the late Mr Trethowan used to say, " It is impossible to do too little." A solitary snap which indicates that one taut avascular adhesion has broken always augurs well, whereas the crunching sound of many short adhesions being torn probably means that a *reactionary effusion will follow and the manipulation may be ineffective* or worse.

When the limitation of joint-movement is due to fibrosed muscle—a condition which should not arise if the treatment described above is carried out—then before manipulating such a joint the question must be carefully considered as to whether it is wise to increase the range of movement of the joint at the expense of weakening the muscles. If it is performed the manipulation must aim at a very small increased range and can, if necessary, be repeated some time later.

X-rayed, and most closed fractures of the skull are not diagnosed until this has been done. The treatment of a depressed fragment of the vertex is not yet standardised and the opinion of a cranial surgeon should always be obtained when this complication is revealed by the X-ray photograph. In general a closed depressed fracture should be elevated in adults but may be left in children unless it is giving rise to symptoms. Closed fractures, other than those associated with a depressed fragment, require no treatment.

OPEN FRACTURES

(1) *The Vertex.*—Open fractures of the vertex are comparatively rare and unless associated with depressed and loose fragments of bone are apt to be overlooked. The greatest care must be taken to explore a lacerated scalp for evidence of underlying fracture and this can only be done if the head is shaved for a wide area around the laceration. Careful toilet of the wound with the local application of penicillin-Sulphathiazole powder is necessary in scalp lacerations and, unless the case is operated upon within 24–36 hours, primary suture may not be advisable. Depressed fragments, if present, should be elevated by the insertion of a lever through a trephine hole in intact bone alongside the depression.

(2) *The Base.*—Fractures of the anterior fossa are usually open into the nose and give rise to epistaxis. In addition there is often a " black eye " with a subconjunctival hæmatoma. This, being retro-orbital in origin, has no visible posterior border, as opposed to the flame-shaped hæmorrhage of direct conjunctival injury where the point of the flame, indicating diminishing hæmorrhage, lies posteriorly. Discharge of cerebro-spinal fluid from the nose is an indication for gentle douching or spraying with a mild antiseptic solution and the patient must be enjoined to refrain from blowing his nose. If this complication persists operative treatment may be required. Fracture of the anterior cranial fossa may be associated with damage to cranial nerves.

Fracture of the middle cranial fossa is usually open into the external auditory meatus, when there will be bleeding from one or other ear, often with rupture of the tympanic membrane. The ear should not be syringed but lightly plugged with cotton-wool soaked in antiseptic. Similarly damage to cranial nerves, particularly the facial and auditory, may complicate this fracture.

The Brain

It has already been suggested that mental derangement is often the most important feature of a head injury. Nevertheless an estima-

CHAPTER XII
THE NERVOUS SYSTEM

I. THE HEAD

THE study of head injuries has passed through two distinct phases and is now entering upon a third. Up to fifty years ago attention was directed primarily to the injury sustained by the bony framework. Whether the skull was fractured or not was the critical consideration. Much space in the older text-books was devoted to describing the different types of fracture which might be encountered, such as "depressed", "pond", "gutter", and "fissured"; and the mechanics of fracture production were discussed at great length. During the last fifty years it has been taught that injury to the skull, although important, is a secondary consideration compared with the injury to the underlying brain. To-day an entirely new conception is evolving. Injury to the skull is investigated and treated; damage to the brain is assessed and the pathological lesion diagnosed if possible; but derangement of the mind is now regarded as the important feature of most head injuries. The orientation is therefore nowadays physiological rather than anatomical, and it is this new approach to head injuries which demands new methods of investigation and new methods of treatment. The management of a head injury will be dealt with, therefore, under three headings—the skull, the brain, and the mind—and in practice every case must be assessed from each of these three points of view.

The Skull

CLOSED FRACTURES

A closed fracture of the skull is rare. It may occur over the vertex, particularly in children, or at the base of the posterior fossa. Fractures of the base are, however, more common in the anterior and middle fossæ and they are almost invariably open into the nose or the ear respectively.

A closed fracture of the skull may be diagnosed by feeling a depressed fragment over the vertex, care being taken to distinguish this from a hæmatoma, or by damage to cranial nerves in a fractured base. In every case of head injury, however, the skull should be

(*vide infra*) will suggest *morphia* poisoning. An examination of a catheter specimen of urine will exclude *uraemic or diabetic coma*. The history obtained from the relatives or the finding of a hypodermic syringe in a pocket may suggest the possibility of *insulin coma*. The problem of diagnosis in a patient smelling strongly of *alcohol* may be insuperable. Is the patient dead drunk with a cut on the head, or has he sustained some serious cerebral damage after a harmlessly convivial gathering? There is no certain way of differentiating the effects of these two influences in the early stages, and such a case must always be treated as if the unconsciousness were due to the head injury.

Investigation

(1) *Central Nervous System.*—Having taken steps to determine that the unconsciousness (if present) is due to a blow on the head and that the diagnosis is therefore one of cerebral contusion, the next task is to note the degree of coma. It might be argued that this investigation is into the state of the mind rather than that of the brain, but the degree of coma is such an important point in assessing brain damage that it must be described here. As will be seen in discussing another type of brain lesion, namely compression, deepening coma is one of the most important warning signs. It must be appreciated that "coma" is a relative term and covers all grades of conditions from those in which the patient is not responsive to any stimulus and "lies like a log" to varying degrees of disorientation. For our present purpose, however, the degree of coma may be measured by such rough standards as "does not respond to any stimulus", "reacts to pin-prick", "recognises his name when shouted", ignoring for the time being the milder degrees of disorientation which are of more importance in assessing the degree of derangement of the mind than of damage to the brain and will accordingly be described later.

The pupils are examined for reaction to light and accommodation. The integrity of the cranial nerves is tested and the tendon reflexes and muscular power of the limbs assessed. The plantar reflex responses are also noted. Abnormalities disclosed by these examinations, particularly affections of individual cranial nerves, will afford a clue to the site of localised areas of contusion—the so-called focal lesions—although it may be difficult to differentiate between a focal lesion of the brain and peripheral damage to a cranial nerve as a result of a fractured skull.

If the patient is unconscious, if he is seriously disorientated, if there is neck rigidity or if he has severe headache, he should be moved to a hospital and have a lumbar puncture performed with

tion of the nature of the cerebral damage has an important bearing on the degree of this mental disturbance. A classification such as the following may therefore be employed in assessing prognosis and treatment.

Concussion

As those who have played football or boxed know, a blow on the head is capable of causing instantaneous unconsciousness followed by rapid recovery without after-effects. There is momentary loss of all reflexes and a drop in blood-pressure. Such a syndrome is here termed concussion. By its definition it is clear that consideration of such a syndrome need not detain us long. If recovery ensues within a matter of seconds or minutes and there are no complications, there is no need for treatment and no precautions need be taken in regard to a speedy return to full activity. Cases of mild injury producing momentary unconsciousness, but succeeded by headache, are considered in this classification under "Contusion". Similarly, cases popularly termed concussion, in which the effects of the blow on the head are prolonged, and which the doctor is often called upon to treat, have probably sustained structural damage to the brain, and these cases are more properly called contusion.

Contusion

Contusion or bruising of the brain causes amongst other effects a prolongation of unconsciousness. This period of unconsciousness may be for a few minutes' or a few weeks' duration, but if it is more than momentary, it argues that the condition is not one of simple concussion. Further, if there are any residual effects, the commonest of which is headache, then more severe damage than concussion is presumed.

Cause of Unconsciousness

In contusion therefore it is possible that the patient will be unconscious when first seen. The primary duty of the doctor who attends an unconscious patient with a head injury is to determine as far as possible whether the unconsciousness is due to the head injury or if it is due to some other cause and the head was injured subsequently as a result of falling. The common causes of loss of consciousness must accordingly be investigated. A complete examination of the cardio-vascular system will indicate the possibility of some intracerebral *vascular accident*, such as hæmorrhage or thrombosis. Pin-point pupils unaccompanied by signs of cerebral compression

(*vide infra*) will suggest *morphia* poisoning. An examination of a catheter specimen of urine will exclude *uræmic* or *diabetic coma*. The history obtained from the relatives or the finding of a hypodermic syringe in a pocket may suggest the possibility of *insulin coma*. The problem of diagnosis in a patient smelling strongly of *alcohol* may be insuperable. Is the patient dead drunk with a cut on the head, or has he sustained some serious cerebral damage after a harmlessly convivial gathering? There is no certain way of differentiating the effects of these two influences in the early stages, and such a case must always be treated as if the unconsciousness were due to the head injury.

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measurement of the cerebro-spinal fluid pressure. This latter procedure is the only accurate way of measuring intracranial tension and perhaps the only reliable way of reducing it if it is raised. Provided the fluid is drawn off slowly the pressure may be reduced to 70–80 mm. without fear of causing a "pressure cone". Withdrawal of 20–30 c.cm. of blood-stained cerebro-spinal fluid has a beneficial effect apart from reduction in pressure. A red-cell count and protein estimation is made on a specimen of the cerebro-spinal fluid, and these investigations are of value in assessing the degree of brain damage.

(2) *Circulation and Respiration.*—The blood-pressure is measured and this investigation is repeated if the patient's condition deteriorates. The pulse- and respiration-rate are recorded each half-hour until it is certain from a sustained improvement in the patient's general and mental condition (which is frequently reassessed) that no possibility of acute cerebral compression is imminent (*vide infra*). A temporary improvement in the mental state may be a "lucid interval" which is a prelude to serious complications, and the pulse- and respiration-rate should be recorded, therefore, until any such improvement has been maintained for several hours.

LACERATION

Cerebral laceration is a more severe form of brain damage, but a differential diagnosis from contusion is not usually possible apart from the finding of much blood in the cerebro-spinal fluid; and indeed it is not necessary, as the treatment of the two conditions is the same. Cerebral laceration carries with it a worse prognosis, as vital centres may have been extensively damaged, and fatal cases exhibiting the "contusion syndrome" are generally found at post-mortem to have sustained a cerebral laceration for which nothing could have been done. Further, because of the more widespread intracranial disturbance, cerebral compression is more likely to follow a laceration than a contusion. The similarity between the two conditions and the fact that their management is identical has led to the introduction of the term "contusion-laceration complex" for this syndrome.

Treatment of the Contusion-laceration Complex

The treatment of cerebral contusion is conservative and watchful. The patient is put to *bed* in as quiet a place as possible and kept in a subdued light. He may be allowed to sit propped up by pillows or to lie flat, whichever he finds the more comfortable. Some patients get intolerable headache when they lie down, others feel giddy when they sit up, symptoms probably related to the cerebro-spinal fluid pressure,

and they should be given the opportunity of finding their own physiologically optimum level. *Nourishment* and *bowels* are attended to as the diet should be light and readily digested. If the patient is unconscious for any length of time and is unable to swallow, then a tube will have to be used for feeding, and the *bladder* should be emptied by catheterisation. One point should not be forgotten, and that is the necessity for the frequently repeated use of sponges moistened in water or paraffin to alleviate the consequences of parched lips and mouth in a comatose patient.

Where there is prolonged unconsciousness, severe headache or mental disorder with a high cerebro-spinal fluid pressure which cannot be controlled by lumbar puncture, the pressure may be reduced by the intravenous injection of 30 c.cm. of 50 per cent. sucrose, or by giving 4 ounces of a saturated solution of magnesium sulphate per rectum and retaining this for half an hour.

Complications

The more uncommon complications, post-contusional *epilepsy*, post-contusional *automatism* and late *hæmorrhage*, all demand the attention of a specialist and cannot be considered here. Post-contusional *headache* and *dizziness* are all too frequent and require the most careful management on the part of the doctor. Later these complications are evidences rather of derangement of the mind than of damage to the brain, and their significance and treatment will be discussed below.

Irritation

Often about forty-eight hours after the receipt of the injury a patient suffering from cerebral contusion becomes irritable, restless and unmanageable. He resents any interference for the purposes of examination, washing or even feeding. He lies curled up in bed, turning away from the source of any bright light. The pathology of this condition is not properly understood. It used to be considered to be due to reactionary œdema of the brain and certainly the cerebro-spinal fluid pressure is usually raised, but this is not invariably so. A lumbar puncture should be performed, provided that the condition of the patient will permit it, and if the pressure is found to be raised it may be lowered by withdrawal of fluid. If lumbar puncture is not possible, it is justifiable to reduce the cerebro-spinal fluid pressure by other means (*vide supra*) on the reasonable assumption that it is raised. Morphia must be used sparingly in these cases, because of the

depressing effect on the respiratory centre, and except in rare cases with maniacal symptoms is better withheld.

COMPRESSION

Lastly we come to the most serious of all intracranial traumatic lesions—cerebral compression. This is the result of intracranial bleeding and may be of two kinds, venous or arterial.

Chronic Subdural Hæmatoma

Venous blood is not of itself under sufficient pressure to compress the brain directly, but it may seep out between the arachnoid and the dura, and form an encysted hæmatoma. This hæmatoma, being of high osmotic tension, enlarges from the absorption of fluid and acting like a cerebral tumour presses on the brain in the vicinity. The symptoms of chronic subdural hæmatoma mimic precisely those of cerebral tumour and may develop very slowly, sometimes after the most trivial head injury. The treatment is operative, and such cases should be submitted to the care of an expert neuro-surgeon. These lesions are rare, and often the connection between them and the original injury can be elicited only after close inquiry.

Arterial Bleeding

The type of bleeding which most closely concerns us in connection with cerebral compression is arterial bleeding. This can raise the tension sufficiently to compress the brain directly, and it is the symptoms and signs of arterial bleeding for which we watch so closely in a case of cerebral contusion. These *symptoms and signs* may be divided into general and local. The first indicate that bleeding is occurring inside the skull ; the second, equally important, indicate the side of the bleeding. The *general signs* are deepening coma, vomiting, slowing of the respiration-rate and a rise of blood-pressure. The pulse is usually slow but may become progressively rapid with deterioration in quality. The *local signs* are a constriction of the pupil on the side from which the bleeding is occurring, followed by a dilatation which ultimately becomes fixed (the opposite pupil following the same course but lagging behind), and a paralysis of the face and limbs on the opposite side. Arterial bleeding may take place in two main situations, each giving rise to the above train of symptoms.

Subarachnoid Hæmorrhage

If arterial bleeding is subdural it comes usually from lacerated brain and will become brisk as soon as the blood-pressure recovers (a moment-

ary reduction of blood-pressure having occurred immediately after the injury). The hæmorrhage will, after perhaps a short interval, start to raise the intracranial pressure and the degree of unconsciousness will become progressively deeper. Although blood issuing from ruptured venous sinuses is not of sufficient tension to compress the brain directly, purely venous subarachnoid hæmorrhage may rarely lead to a serious rise of intracranial tension by interference with the mechanism of absorption of cerebro-spinal fluid. If there is a profuse hæmorrhage, the corpuscles floating within the subarachnoid space act like foreign bodies and choke the perivascular sinuses, arachnoid villi and Pacchionian bodies, which are thought to be the channels of cerebro-spinal fluid resorption. The onset of symptoms may then be delayed, but the final picture is identical with that of compression due to arterial hæmorrhage and is treated on the same lines.

Extradural Hæmorrhage

If the bleeding is extradural, then before it can exert any marked influence on the cerebro-spinal fluid pressure it has to strip away the dura from the inside of the skull. This process may give the brain time to recover from the early effects of the head injury before it is once more plunged into oblivion by the compression, and so the well-known " lucid interval " may appear which constitutes such a pitfall for the unwary.

Treatment

The appearance of symptoms and signs of compression by hæmorrhage is an indication for immediate *craniotomy* on the side of the bleeding so that it can be stopped, or if this is impracticable, as in some cases of venous hæmorrhage, the blood and blood-clot can be evacuated. Attention has been called to the danger of using Sulphathiazole as a dressing in these cases (p. 32).

The Mind

Just as structural damage to other organs may derange their *function*, so structural damage to the brain may lead to mental *derangement*. Similarly, just as an organ which is initially and constitutionally defective is apparently more affected by trauma than a normal organ because the margin of safety is less, so it is with the mind.

Many of the immediate and most of the residual symptoms of cerebral contusion are due to derangement of the mind; and as cerebral contusion is an element in practically all brain injuries, the importance of the mental aspect will be appreciated. Investigation

of a patient from this point of view resolves itself into two parts—the state of the mind at the moment and the mental background upon which this state has been grafted.

THE MENTAL STATE

A patient with a head injury may exhibit any degree of mental attitude ranging from deep coma (the quasi-philosophical meaning of the terms "unconsciousness" and "coma" must not detain us here), light coma, disorientation of a greater or less degree up to the normal for that patient. Tests for the severe degrees of derangement have been discussed in dealing with the brain, and a few rough tests were described which would serve to estimate the degree of coma. It is the mild degrees of disorientation with which we are primarily concerned here. The general attitude of the patient must be noted. He may be somnolent, loquacious, disagreeable, amorous or maniacal. His method of speech and his gestures are observed and certain questions may be put to him to test his awareness of his surroundings. It is not only the answers to these questions which are important but the time taken to answer them and the manner of the replies. Thus he is asked his name, age, birthday, address, names of members of his family, the name of the Prime Minister, the colours of the traffic lights and certain questions relating to topical events, the answers to which he might be expected to know, such as "What happened at Dunkirk?" or alternatively "What is the capital of England, Scotland, U.S.A.?" and so forth.

From such a catechism a fair idea of the patient's degree of awareness may be obtained When at any time after a head injury he responds satisfactorily to these preliminary tests his mental function may be further probed by more elaborate methods. Three of such tests, which are taken from the programme for head patients at the Oxford Head Injury Centre, have been found of great value and are reproduced here.

(1) *The 100 — 7 Test*

The patient is asked to subtract 7 from 100, take 7 from the result and so on until he reaches the number 2. An ordinarily intelligent patient should be able to do this accurately in 30 seconds.

(2) *The Digit-retention Test*

A number of digits are recited to the patient at the rate of two digits a second, and the patient should then repeat them. First a series of three digits is given, then four, five, six, seven, and so on, until it is

found that the limit of the patient's retention has been reached. The ability to retain 7 digits in three consecutive attempts is a satisfactory response.

Digits may then be repeated in the reverse order, a feat which demands higher qualities of the mind and one which is often difficult to perform during the phases of impairment following a head injury. Ability to perform this test with six digits is satisfactory.

The following series of digits is used at Oxford :

1	2	3	4
582	694	641	352
6439	7286	4729	3852
42731	75836	31859	48372
619472	392487	473859	529746
5917428	4179386	2183439	9728475
58192647	38295174	72594836	47153962
275862584	713942568	596138274	925841736

(3) A short story is recited and the patient is asked to repeat this. The story should be repeated factually correct and showing that the point has been understood. The following story is a useful one :

The Cowboy Story

" A cowboy went to San Francisco with his dog, which he left at a friend's while he went to buy a new suit of clothes. Dressed in his grand new suit, he came back to the dog, whistled to it, called it by name, and patted it. The dog, however, would have nothing to do with him in his new coat and hat, and gave a mournful howl. Coaxing was of no avail, so the cowboy went away and put on his old suit and the dog immediately showed its wild joy on seeing its master as he thought he ought to be."

In addition to these tests the patient's mental condition is revealed by his own expression of his capacity or incapacity to perform mental functions of which he was previously capable. Thus, he may find reading the newspaper or close attention to a book a tiring experience. Concentration is often at fault and games such as chess and work which requires much concentration are often impossible long after the other symptoms of mental derangement have passed away. Mental abnormality may reveal itself not only in failure of adequate physiological response, which the foregoing tests have been designed to expose, but also in the pathological response of neurosis. Thus headache, which

may be " real " enough initially, is perpetuated as a neurosis. Similarly stammer, slovenly behaviour, indecency, laziness or mental instability of one sort or another, as well as frank insanity, may have their origin in a head injury. These pathological responses are almost invariably grafted on to a mind which was initially unstable and it is necessary, therefore, to assess the mental background, both in order to establish the patient's previous mental level and compare this with his responses to the above tests and also to gauge his liability to neurosis.

The Mental Background

A complete family and personal history is obtained, paying particular attention to any "nervous breakdowns", fits or irrational behaviour, headaches, enuresis, etc. Inquiries are made into the patient's scholastic attainments, if he played games, if he was a good mixer and was well liked by his fellows; whether he is of a happy, contented disposition or if he is liable to fits of depression. Does he get on well with his family and does he make friends easily? How much does he drink and smoke? What are his hobbies and his interests or intellectual pursuits?

It is necessary to know what his job is and how much he earns at it; if he is satisfied with his lot; whether he is ambitious or, alternatively, if he feels that he is a round peg in a square hole. In short, whether he has a well-adjusted, stable mentality with a good family background or if he is a psychological misfit with a hereditary tendency to mental instability.

Armed with this knowledge and with a measure of the patient's present mental condition it is possible to assess the severity of mental injury and to prescribe treatment. Before this aspect is discussed, however, it is proposed to give a scheme outlining the method of examining a head case which has been found of value in practice and embraces an investigation into the state of all three factors concerned—the skull, the brain and the mind.

General Investigation of a Head Case

(1) A history is taken from third parties as to the nature of the accident and any relevant details in the history such as vomiting, bleeding from the nose, ears, etc.

(2) The patient is questioned and an assessment made of his degree of coma or disorientation, using in the latter case the preliminary tests described above. Particular attention is paid to the length of retrograde amnesia and post-traumatic amnesia (P.T.A.), the latter being

the most important single piece of evidence available at this stage as to the severity of the mental damage.

(3) If the patient is comatose an examination is made of the cardio-vascular system and of the urine to eliminate other possible causes for the patient's condition.

(4) The head is examined for laceration, depressions on the vertex, bleeding from the ears or nose, subconjunctival hæmorrhage and neck rigidity.

(5) An examination is made of the central nervous system, paying particular attention to the pupils, the tone of the limb musculature on the two sides, and the tendon and plantar reflexes.

(6) The patient is put on a pulse chart and the blood-pressure is taken. The respiration-rate is recorded each hour and the temperature taken every four hours, and these investigations, together with repeated reassessment of the depth of coma, are carried out until there is judged to be no danger of cerebral compression.

(7) In cases of (*a*) *coma*, (*b*) *neck rigidity*, (*c*) *severe headache* or (*d*) *deterioration after a preliminary recovery*, the patient is taken into a hospital, a lumbar puncture is performed, the pressure measured and the fluid examined for red blood-cells and protein content.

Lumbar puncture is contra-indicated when there is rigidity of all four limbs (*decerebrate rigidity*) or a *dilated, fixed pupil*. These are signs of herniation of the brain through the tentorium cerebelli due to increased pressure above this level. Decompression of the lumbar subarachnoid space would serve only to aggravate a tentorial hernia of this type.

(8) On the following day or as soon afterwards as the patient is fit to co-operate, he is examined with the 100 — 7 test, the digit-retention test and the "cowboy story". The skull is X-rayed.

(9) The mental background is assessed.

(10) The mental tests are repeated every few days with variations (e.g. 100 — 8 test, different stories, etc.) until the patient's mental state is judged to be recovered. In severe injuries (e.g. P.T.A. greater than 24 hours) the mental impairment should be assessed by expert psychometric analysis before the patient is discharged to full work.

Treatment

At first the patient is put to bed in a quiet room or in the corner of a ward behind screens. If there is severe headache a mixture of Aspirin gr. v, Phenacetin gr. v and Heroin gr. $\frac{1}{8}$ may be prescribed. Later, Veganin gr. v is the most reliable drug for the relief of headache.

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Phenobarbitone gr. $\frac{1}{2}$-1 n.mque., or chloral hydrate gr. x t.d.s., is prescribed for restlessness. The bowels are attended to and a light nourishing diet is given.

The subsequent treatment depends upon the mentality of the patient. Reassurance and encouragement are always justifiable and often necessary. If he is a stable-minded, sensible fellow his treatment is largely prescribed by himself. He reads, listens to the wireless and receives visitors when he feels inclined to do so and he gets up when he feels fit, although with this type of patient it is wise to wait until all headache has disappeared and until he is completely orientated before allowing him out of bed. No specified time can be laid down as to when to allow a patient with a head injury to get out of bed. It is a matter of trial and error, and often a patient who has no headache and who is completely orientated gets up, only to find his headache returns or he feels dizzy, in which case he has to go back to bed for another day or two to try again later. As a rough guide it will often be found that a patient who has suffered less than an hour's post-traumatic amnesia can get up in about a week, whereas those who have had many hours' post-traumatic amnesia may not be able to get up for two or three weeks.

In the same way the stable-minded patient controls his subsequent activities. He may visit the cinema or take mild exercise up to the limit of what he knows to be his tolerance until his mental and physical powers are completely restored, when he may return to work.

Prognosis

Cairns (*Proc. Roy Soc. Med.*, 1942, 35, 299), using the yardstick of post-traumatic amnesia, suggests that the shortest time in which a patient with a head injury is likely to return to work is as follows :

P.T.A.	*Return to Work*
5 mins.–1 hour	4–6 weeks
1–24 hours	6–8 ,,
1–7 days	2–4 months
Over 7 days	4–8 ,,

This table, however, is subject to striking exceptions and should be used only as a very general indication of the periods of disability. Focal lesions particularly, although often attended by very short periods of amnesia, may postpone recovery for months or years.

Further experience has shown, moreover, that many cases return to work earlier than would be anticipated from the above table (Symonds and Ritchie Russell, *Lancet*, 1943, 1, 7). This method of assessing prognosis, besides being vitiated by numerous exceptions, is open to the objection that the precise period of P.T.A. is often very difficult to gauge. It may be unduly prolonged by the administration of morphia and other sedatives, or it may be apparently shortened by the patient remembering what he has subsequently been told had occurred and imagining that he remembered the occurrences themselves. Nevertheless, it has been included in order to give some idea as to the period of incapacity which may be expected in the majority of cases.

A more accurate guide to prognosis will probably result from psychometric analysis, whereby the patient's mental recovery is followed and, in a rough way, measured at intervals during his convalescence by means of the performance of standard tests; but at the time of writing this method has not been practised long enough for it to be of precise value in this respect, although it may be stated that the degree of mental impairment found ten weeks after a head injury is likely to be largely permanent. Finally, in cases where there is any doubt as to the capacity of a patient to return to his employment, psychometric analysis will often reveal a hidden disability which will rapidly disappear after a short period of convalescent treatment, and such an analysis should always, therefore, be undertaken in a severe case before subjecting him to the full rigours of his previous employment.

In the instance of the mentally unstable the management of the case presents far more difficulty. There is the rare case of the over-anxious and eager patient who tries to do everything too quickly and has to be restrained; and there is the far commoner type, of which a proportion of compensation and Service patients form the majority, who exaggerate their symptoms, develop neurotic or psychotic manifestations, such as persistent headache, and whose return to health, if indeed they ever completely recover, is along a path strewn with obstacles and scarred with pitfalls. The treatment of such patients is primarily the concern of the psychiatrist, and if a patient with a head injury fails to show a steady recovery, and particularly if he is of an unstable mentality, then the services of a psychiatrist experienced in the treatment of these injuries must be enlisted before the patient becomes confirmed in his neurosis. An electro-encephalogram may be helpful in such cases in determining the degree of brain damage and in following the recovery.

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spines, the backs of the *heels*, the *tibial malleoli*, the heads of the *fibulæ* and the *inner sides of the knees*. First an area of congestion appears which becomes purple and eventually black and gangrenous. These patches rapidly become infected and the surrounding tissue is red and œdematous. The central area breaks down and is cast off as a slough, and a large ragged ulcer, sometimes burrowing deeply into the tissues, is left behind which discharges foul pus. Toxic absorption from these areas undermines the patient's health and he may succumb to septicæmia.

Treatment

Frequent changes of posture are necessary to prevent pressure operating upon any one site for too long. This is difficult to effect and may be dangerous in a patient with a fracture-dislocation of the spine. Accordingly it is necessary that the fracture should be immobilised in a *plaster jacket* as soon as possible. Once this has been done the patient can be moved freely and frequently without fear of causing further damage to the spine. If recovery of sensation does not occur within a few days, then this jacket must be split into two halves, so that one half can be removed at a time whilst the patient lies in the other half for regular attention to the skin. If a *plaster bed* is used, then an anterior half must also be made for the same purpose. Cotton-wool is bandaged lightly under the heels and around the knees; and the legs below the knees are rested on well-padded, light plaster " back-slabs " to prevent foot-drop.

In *gun-shot wounds* of the spine which are not subjected to plaster the patient should be nursed on a *water-bed*, or less satisfactorily on a firm rubber mattress. The water-bed should be filled to such a tension that the surgeon, leaning with all his weight on his two fists, can just make contact between the two surfaces of the bed. The *skin* must be treated four times a day by washing with *alcohol*, drying lightly with a soft towel and powdering with a fine talc or boracic *powder*. The greatest care should be taken to see that the skin is not wetted with urine, but where this is unavoidable *olive-oil* should be rubbed lightly into the contaminated area. For an *established sore, zinc oxide ointment* may be used as a dressing, and this may be combined with *Fuller's earth* or *Tinct. Benzoin. Co.*; but when the sloughs start to separate, packing with *Eusol* is to be preferred. After separation some surgeons advocate an *Elastoplast* strapping applied directly over the sore. As in the similar treatment for carbuncles, this splints the skin and provides complete rest for the part; it is probably the method of choice where the area is not likely to be contaminated with urine

II. THE SPINAL CORD

Paralysis of the spinal cord may follow inflammation or neoplasm, but is most commonly encountered in association with a fracture of the spine, and although the principles of after-care are the same whatever the cause, fracture is so far the commonest that the problem will be considered from that aspect. It is not proposed to discuss the treatment of the fracture itself, as this is the province of the surgeon. If the spinal cord has been damaged, then the bony lesion is likely to be a fracture-dislocation, and in order to prevent the spine flexing and thereby dislocating still further the patient is, in the first instance, *nursed and transported in the prone position.* Later, manipulation or extension (at times after open operation) followed by a plaster jacket or a plaster bed will be necessary. If, as after a bullet wound of the spine, the cord is paralysed but the integrity of the bony column is maintained, then plaster fixation of the spine may not be necessary.

Prognosis

With regard to prognosis it may be said that incomplete paralysis carries a better prognosis than complete paralysis as far as ultimate functional recovery of the cord is concerned. After a week a fair idea of the prognosis can be obtained. *Unfavourable signs* are (*a*) persistent loss of all reflexes (except flexion of the toes on stimulation of the soles); (*b*) loss of all power of movement; (*c*) loss of sensibility in the legs; and (*d*) absence of sense of position in the great toe. In cases which are likely to recover, some improvement in sensibility and to a less extent of movement will have become apparent in a week.

Death after cord paralysis may be due to *broncho-pneumonia,* particularly when the lesion is high in the thoracic region and the use of the accessory muscles of respiration is lost; septic absorption from *bed-sores*; and *ascending infection of the kidneys.* The after-care of these patients is directed particularly towards combating these evils.

Chest Complications

Chest complications are inevitable in high lesions of the cord and apart from postural treatment there is little that can be done.

Bed-sores

Bed-sores are liable to develop with surprising rapidity in areas rendered anæsthetic by the cord lesion. Attention must therefore be directed to this complication from the first hour. Common sites are over the back of the *sacrum,* the *greater trochanters,* the *anterior iliac*

moments without the patient being aware of the fact, so that a particularly cumbersome apparatus has to be worn, and he is far better off with a permanent suprapubic cystostomy.

Suprapubic Cystostomy

The successful working of a system of tidal drainage requires a somewhat complicated piece of apparatus and considerable skill and experience in its management. If these are not available a suprapubic cystostomy should be performed. This is done through a stab wound with a trocar and cannula into the bladder. On removal of the trocar, a self-retaining catheter is passed through the cannula, which latter is itself then withdrawn over the catheter. Puncture of the paralysed bladder with a trocar and cannula in a case of spinal injury is far from being the simple procedure which the same manœuvre is when performed on the tense distended bladder of prostatic obstruction. The vesical musculature in the former case is often so lax that unless a clean exposure is made of the anterior surface and unless the trocar is very sharp it may push the bladder wall before it instead of penetrating it. The catheter should be connected to a modified Cuthbert Dukes' apparatus (p. 174), or may be led to a container under the bed, and intermittent washing of the bladder with a few ounces of normal saline is carried out every 2 hours. If there are phosphatic incrustations, the bladder is washed out with a few ounces of acetic acid (B P. one drachm to the pint), followed by saline to remove the acid. A cystitis or pyelitis due to Bacillus coli communis is treated with a course of sulphonamide. Every few days the suprapubic tube is clipped off for 6 hours to test the function of the bladder and to see whether voluntary or automatic control has been acquired. The suprapubic cystostomy is retained until voluntary micturition becomes re-established when, if the urine is not grossly infected, the suprapubic tube is removed and the hole allowed to close. If " automatic bladder " persists then it is better, as has been discussed, to retain the suprapubic cystostomy permanently. The suprapubic catheter is changed after fourteen days and thereafter monthly.

If neither of the two methods described above is practicable because of lack of equipment or unsuitability of environment, the bladder should be left to overflow and the patient [illegible], all due despatch [illegible] bladder [illegible] it is anticipated that the patient will be without expert supervision for more than 48 hours, a needle (fine lumbar-puncture or " Wassermann " needle) can be passed into the bladder suprapubically and up to 30 ounces of urine

or fæces. Later, when granulation tissue appears, *artificial sunlight* may stimulate healing or *skin-grafting* may be considered

Care of the Bladder

After all spinal cord injuries and especially after injuries to the cauda equina there is retention of urine for a variable period. This retention, if not relieved, leads to distension and atony of the bladder musculature and may permanently impair its function. Furthermore, the stagnation of the urine tends to infection, and this, by ascent to the kidneys, may determine a fatal issue. Unless, from the nature of the injury, it is quite certain that voluntary control of micturition is lost, attention to the bladder may be deferred for 18 hours. If, at the end of that time, no urine has been passed or if the bladder can be felt to be distended above the pubis, 1 c.cm. of Carbachol (or similar antispasmodic) is injected subcutaneously. Sometimes the bladder will evacuate spontaneously following this injection, but if no urine has been voided within another hour, steps must be taken to decompress the bladder.

Tidal Drainage

This is the most effective method of bladder decompression in spinal cases. The apparatus and technique of its use are described on p. 175. The indwelling catheter is changed every third day and at these times the catheter is left out for a period of six hours to see if "automatic bladder" (that is, a bladder which evacuates its contents reflexly when distended) has developed. As soon as "automatic bladder" appears, and if the urine is not grossly infected, the apparatus may be discarded. At this stage the male patient lies in bed or sits in a chair with his penis in a urinal and the female patient applies a wad of cotton-wool between the legs, which is changed after each evacuation. After a variable period voluntary micturition may return. The first evidence that this is occurring is the sensation of wanting to micturate when the bladder becomes distended. If this sensation has not returned in six months, voluntary control of bladder function will probably never be regained. Accordingly a decision has to be made between leaving the patient with an "automatic bladder" or performing a permanent suprapubic cystostomy (p. 189). A very few patients can control the working of their "automatic bladder" by powerful contraction of the abdominal musculature or by manual compression above the symphysis, and in such patients life with an "automatic bladder" may be endurable. Usually, however, the bladder empties itself at the most unexpected and inconvenient

readily distinguished from the coarse fibrillation of progressive muscular atrophy, where the lesion is of the anterior horn cells. After about ten days the *reaction of degeneration appears* in which the muscles will respond to galvanic but not to faradic stimulation. Sensory loss leads to *anæsthesia* of the cutaneous area involved and ultimately to the appearance of *trophic sores* and ulcers. After a few days the area of sensory loss contracts, due to the compensatory overaction of the neighbouring intact nerves, and this should not lead the examiner to assume that recovery is occurring. Vaso-motor disturbances lead to *blueness*, *ædema* and a *glossy appearance* of the skin, and there is also an *absence of sweating* due to paralysis of the secretory fibres to the sweat glands. Loss of spontaneous movement, unless energetically treated by passive movements, will lead to adhesions and *contractures of joints*.

CAUSALGIA

Occasionally partial lesions, especially of the median and sciatic nerves, will be accompanied by a very intractable form of pain along the course of the nerve. This type of pain is called "causalgia". It may persist for some months, but sometimes disappears spontaneously. If there is no sign of spontaneous recovery, the operations of alcohol injections, posterior rhizotomy and antero-lateral tractotomy, although resorted to in desperation, are usually a waste of time. Sympathectomy is sometimes tried.

Nerve Suture

It may be difficult to decide whether to suture the divided nerve at the same time as the wound is being dealt with (*primary suture*) or to delay operation upon the nerve itself until after the wound has healed (*secondary suture*). If there is any doubt about the possibility of the wound becoming septic, then secondary suture should be practised, as the prognosis of secondary suture following unsuccessful primary suture is very bad. The prognosis of secondary suture is not much affected by the time which elapses between the injury and the operation for nerve suture, provided that this is *not longer than six months.* The results of nerve suture have, however, in the past been so relatively unsatisfactory that an attempt is being made nowadays to improve the prognosis by operating as soon as possible. After six months the prognosis becomes progressively worse and after three years the operation of secondary suture is not worth considering. On the other hand, it is useless to attempt secondary suture until the wound has completely healed, until all signs of sepsis have disappeared, and until the nerve has been given an opportunity to regenerate spontaneously. Accordingly, the usual time for performing this opera-

may be withdrawn by means of a syringe. The needle should be passed within half an inch of the upper border of the symphysis pubis, and this procedure should not be practised on more than two occasions.

Care of the Bowels

Just as there is a tendency to retention within the bladder there may be retention within the bowel and *abdominal distension* and *tympanites* may be serious complications.

Posture, enemata, subcutaneous injections of eserine and the passage of the flatus tube help to overcome these, and digital removal of hard fæces is often necessary. In a simple crush fracture of the bodies without cord involvement the putting on of a plaster jacket is deferred for forty-eight hours to allow the worst effects of the abdominal distension to subside before subjecting the patient to the additional restricting discomfort of the plaster. In the meanwhile the patient is nursed on his face with pillows arranged under the shoulders and under the thighs to maintain hyperextension of the spine. This method can be adopted only if the co-operation of the patient can be relied upon and he can be trusted to stay in this position without restraint.

Deformities and other Complications

Drop foot, flexion of the hips and knees and *adductor spasm* leading to "*scissor leg*" must be prevented by the use of a cradle and well-padded splints.

Years after a cord lesion severe root-pains may develop due to *radicular arachnoiditis*. This pain may be so intolerable as to demand posterior rhizotomy or antero-lateral tractotomy. *Encysted serous meningitis* may lead to an arrest in recovery or to the reappearance of pressure symptoms months or years after the injury. It is treated by operation.

No *final assessment of recovery* can be made for two years, as improvement may take place up to that time.

III. THE PERIPHERAL NERVES

The Clinical Aspect

Injuries to peripheral nerves lead to various changes in the structures which they normally innervate.

Firstly loss of conductivity in the motor fibres produces *paralysis, wasting* and *loss of tone* in the muscles supplied. The reflexes are absent and after a few days a fine *fibrillary twitching* appears. This fibrillary twitching taking place in the individual muscle fibres can be

thumb of the glove are secured by elastic bands passing along the dorsal surface of the fingers, thumb and hand to hooks at the back of the wrist. This holds the fingers and thumb in extension while at rest, and the flexors may be exercised continually against the pull of the elastic bands. If there is a tendency to hyperextension at the distal interphalangeal joints, the elastic bands should be strapped to the glove over the terminal phalanges. Brian Thomas has devised a simpler apparatus which is almost equally effective in radial nerve palsy. A strong springy wire is incorporated in plaster around the forearm. This wire is placed so that it lies along the back of the forearm, emerges from the plaster over the metacarpo-phalangeal joints and, taking a wide sweep, arches forwards to end in a loop. A pencil is passed through the loop after the latter has been pressed forwards between the middle and ring fingers. This pencil takes purchase on the proximal interphalangeal joints, keeping the metacarpo-phalangeal joints in extension, but allowing the flexors of the fingers to exercise actively against the resistance of the spring of the wire. A second wire and an elastic band can be made to serve the same function in regard to the thumb. The paralysed joints are put through a full range of movement at least twice a day, and the circulation of the part is increased by hot baths and radiant heat. Massage and galvanism help to prevent wasting. In complete nerve lesions galvanic stimulation only is effective, but should recovery occur, faradic stimulation will be found effective and should be substituted. As soon as any *spontaneous movement* appears, encouragement of this takes precedence over all other forms of treatment. If possible the help of a trained physiotherapist should be obtained who should direct the exercises for re-education of the part. After the operation for suture of a nerve, whether this be primary or secondary, the

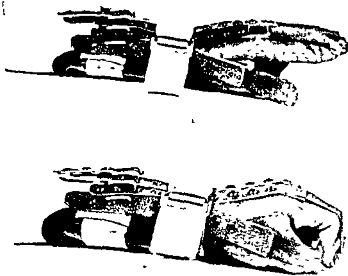


FIG 60.—The splint in use.

tion is from three to six months after the original injury, depending upon the progress of the wound and the length of nerve which has to regenerate. In the meantime, following the operation on the wound and while waiting for the operation for suture of the nerve, a great responsibility devolves upon the doctor who is looking after the case. It is most important that the function of the limb should be preserved as far as possible in order that the secondary suture may have a chance of being physiologically successful.

Physiotherapy

The limb is splinted so that the paralysed groups of muscles are relaxed. In splinting a paralysed hand, great care must be taken to see that the splint is light, well fitted and comfortably padded, otherwise trophic sores are bound to appear. Bremner Highet (*Lancet*, 1942, 1, 555) described a number of different splints for the hand which are of exceptional value in cases of median, ulnar and radial nerve palsies. For a detailed description of these splints reference should be made to the original paper, but each is designed to hold the fingers or thumb in such a position that the paralysed muscles are relaxed, at the same time allowing exercise of the paralysed joints to take place.

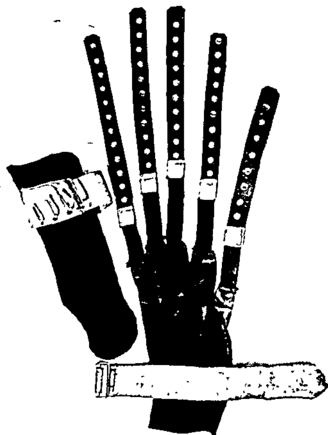


FIG 59 —The component parts of the splint used in radial nerve palsies

Fig. 59 illustrates the splint employed in the common radial nerve palsy. The splint consists essentially of a glove. The fingers and

CHAPTER XIII

OPERATIONS ON CHILDREN

I. GENERAL PRINCIPLES

SURGERY on children presents a balance-sheet of assets and liabilities which is in many ways different from that of surgery on adults. The most valuable asset is the immense power of repair of young, growing tissues. Bones united in mal-alignment gradually modify their form so that in a few years all traces of a fracture have disappeared; the fractures themselves unite rapidly and surely; stiff joints regain their movement with a facility which is never equalled in later years and even irremediable deformities are disguised and compensated so that loss of function is reduced to a minimum. Psychologically, moreover, children are excellent patients. They do not entertain the morbid fears which may beset their elders and which tend to prolong convalescence. They are hopeful and eager, and subconsciously straining to get well. They do, or can be made to do, what they are told and it is unusual for them to consider that they know better than their medical attendant.

On the other side of the balance-sheet is first a tendency to keloid scarring, a tendency which is derived from the very exuberance of the tissue-growth which ensures repair; and second, in certain situations, an inability to resist infection. This latter is particularly evident within the peritoneal cavity where infection carries a graver prognosis than with advancing years. Finally, having a greater proportion of surface-area to body-weight, they have, like most small animals, a high basal metabolic rate and their fluid and salt balance is the more readily upset.

Fluid Requirements

For a full discussion of this problem the reader is referred to an article by Arnott and Young (*Lancet*, 1942, 1, 523), where the fluid requirements of children are worked out according to their surface-area. The details are perhaps calculated to a degree of precision which is unnecessary and unlikely to be attained in practice, but the main findings are of the greatest value. According to these workers

physiotherapeutic measures indicated above are persisted in for at least a year, or until the function of the part is normal.

Prognosis

Prognosis in nerve suture depends upon many factors, some of which, such as the technique employed and the skill and experience of the operator, do not concern us here ; but in general we may say that the physical and psychological after-treatment has as much to do with a successful issue as any other factor. The prognosis is better in children than in adults ; it is better in a predominantly motor or sensory nerve such as the facial, trigeminal or radial, than in a mixed nerve such as the ulnar or sciatic. Further, the higher the lesion in the nerve (unless this involves a nerve plexus) the better the prognosis.

In assessing the extent of recovery after nerve suture *two standards* are adopted—*the neurological and the economic.* It may be said that where the neurological recovery is good, as in the radial nerve, the economic recovery is also good ; but the reverse is not always the case. Thus a lesion of the ulnar nerve with poor neurological recovery is of little disability to a labourer doing heavy work. In median nerve lesions with poor neurological recovery, anæsthesia and trophic sores of the index finger often render the hand of very little value, whilst causalgia has always to be reckoned with in this nerve.

Partial lesions of the external popliteal nerve have a good prognosis, but complete lesions do not often recover. Orthopædic correction of the deformities and an efficient apparatus, however, often make lesions of this nerve of little economic consequence. Injuries to the sciatic nerve are very serious. Apart from the possibility of causalgia, recovery of the posterior tibial branch is unusual and the intrinsic muscles of the foot never recover. The foot becomes fixed in plantar flexion due to the paralytic contracture of the bulky calf muscles and pressure-sores appear on the toes and heels so that amputation may be necessary.

in may be adopted, but with the smaller volumes of fluid required a better plan is to use 4 per cent. glucose in $\frac{1}{5}$ normal saline. A close watch must be kept on the chloride output in the urine, and if this is excessive as shown by the silver nitrate test (p. 11), 5 per cent. glucose in distilled water should be substituted. The volume of fluid run in is based on the table given above, but this may be checked, at least in older children, by measuring the urinary output, which, at the age of five or six, should be over 500 c.cm. in the twenty-four hours and of a specific gravity less than 1,030.

Other Considerations

Sedatives are not usually required post-operatively in children. They are not mentally anxious and the natural reaction of a child to surgical insult is to sleep it off. If drugs are required because of pain they should be prescribed in the doses advised on p. 5. Whereas morphia is indicated in full doses in cases of peritonitis in adults, it should be withheld in children. This empirical finding is substantiated by the results in a large series of cases of peritonitis treated at the Great Ormond Street Hospital for Sick Children. It was observed that the mortality in cases of appendicitis was reduced to less than half its previous rate following, and presumably as a result of, withholding morphia. After tonsillectomy, also, morphia is unsatisfactory, as it induces a thick, ropy, mucous secretion into the mouth which is troublesome and irritating to the patient.

In cases of peritonitis, at the first sign of epigastric distension or discomfort and where there is vomiting, a duodenal tube should be passed through the nose and is surprisingly well tolerated. Suction drainage is employed as described on p 12 (Fig. 1). Fluid may be given by the mouth as the patient requires and this is sucked up in the duodenal tube. All fluid requirements are met by an intravenous infusion as described above.

II. ABDOMINAL OPERATIONS

Congenital Hypertrophic Pyloric Stenosis

Two problems are of outstanding importance in the after-treatment of operations for this condition, namely, diet and the prevention of enteritis, which latter is responsible for the majority of post-operative deaths.

Diet is more or less standardised and the routine followed at most of

the fluid requirements of children in the twenty-four hours are expressed in the following table :

1 year	750 c.cm.
3 years	1,000 c.cm.
8 years	1,500 c.cm.
12 years	2,000 c.cm.

These results correspond closely with the volumes of fluid found empirically to be satisfactory for children suffering from peritonitis (p. 144), and may be adopted as a sound rule which can be modified to suit unusual cases, where the weight of the child is much above or much below the average.

Children who have undergone a small operation and who are not acutely ill can often take the full fluid requirements by the mouth. Four to six hours after the operation the patient can sip half an ounce of fluid half-hourly and this volume is gradually increased until the required amount is reached. The fluid should be liberally sweetened with glucose and flavoured with lemon. An intake of two or three ounces of glucose in the twenty-four hours should be aimed at. Barley-sugar, fruit-drops and other boiled sweets are useful additions to the glucose intake and are usually consumed with relish. If the child is seriously ill, he will not be able to take all the fluid by the mouth and supplementary methods must be adopted. If the deficit is not great it can be made up by rectal feeds. A rectal drip-infusion apparatus is set up and tap-water or $\frac{1}{5}$ normal saline run in. Glucose is not well tolerated by the rectum in these cases, so that the oral fluid must contain all the glucose required. On the whole, rectal feeding is unsatisfactory in children. The presence of the rectal tube fusses the child and if more than a pint of fluid is required in the twenty-four hours it is liable to be voided into the bed.

Intraperitoneal infusion of fluid is an unsatisfactory method and its employment usually implies that the doctor has not sufficient dexterity to insert a needle or a cannula into a vein. If a child is vomiting to more than a trivial degree, if he suffers from peritonitis, after operation upon the intestines or when he is too ill to take a large proportion of his fluid orally, an intravenous infusion apparatus must be set up which should deliver the whole of the child's fluid requirements.

The principles of intravenous fluid administration have been dealt with above (p. 7), but it must be stressed that in these patients there is a very great danger of overloading the system with chloride. The principle described above of substituting a pint of normal saline after three pints of 5 per cent glucose in distilled water have been run

ARTIFICIAL FEEDING: (Commence three and a half hours after operation.)

Hours after operation		
3½	1 dr.	7·5 per cent. glucose in half-strength normal saline.
4	1 dr.	ditto.
4½	1 dr.	ditto.
5	1 dr.	ditto.
5½	1 dr.	ditto.
6	1 dr.	ditto.
6½	1 dr.	ditto.
7	1 dr.	ditto.
7½	1 dr.	Half-strength ½-cream Cow & Gate Special Formula.
8½	2 dr.	ditto.
9½	3 dr.	ditto.
12	4 dr.	Full-strength ½-cream Cow & Gate Special Formula.
13½	6 dr.	ditto.
15½	1 oz.	ditto.
17½	1 oz.	ditto.
19½	1 oz.	ditto.
21½	1 oz.	ditto.
23½	1½ oz.	ditto.
25½	1½ oz.	ditto.
28	2 oz.	ditto.
31	2½ oz.	ditto.

Then six feeds of 3 ounces for twelve hours. Thereafter increasing in volume and spacing of feed until normal feeding for age is regained. Water is allowed by the mouth in small quantities between the feeds.

Cow & Gate Special Formula (Full-strength):

½-cream Cow & Gate Special . . .	2½ dr.
Dextrimaltose	1 dr.
Lactic acid (B.P.)	10 m.
Water	2 oz.

In regard to the prevention of enteritis, all that can be done is to isolate the child as far as possible whilst he is in hospital, and to

the large children's hospitals is much the same. Levi (*Brit. Med. J.*, 1941, 1, 963) gives a table which is used at the Infants' Hospital and which is reproduced herewith.

The mortality in bottle-fed infants is, in all series, many times that of the mortality in breast-fed infants, so that every endeavour must be made to see that the mother can attend the hospital regularly for the purpose of having the breast-milk drawn off or later for nursing the baby herself.

BREAST FEEDING: (Commence three and a half hours after operation.)

Hours after operation		
3½	1 dr.	7·5 per cent. glucose in half-strength normal saline.
4	1 dr.	ditto.
4½	1 dr.	ditto.
5	1 dr.	ditto.
5½	1 dr.	7·5 per cent. glucose in half-strength normal saline and ½ dr. breast-milk.
6½	1 dr.	7·5 per cent. glucose in half-strength normal saline and 1 dr. breast-milk.
7½	1 dr.	ditto.
9	3 dr.	Breast-milk.
10½	4 dr.	ditto.
12	6 dr.	ditto.
13½	1 oz.	ditto.
15½	1 oz.	ditto.
17½	1 oz.	ditto.
19½	1 oz.	ditto.
21½	1 oz. 2 dr.	ditto.
24½	1 oz. 2 dr.	ditto.
27½	1½ oz.	ditto.
30½	1½ oz.	ditto.
33½	1 oz. 6 dr.	ditto.
36½	1 oz. 6 dr.	ditto.
39½	2 oz.	ditto.

Then six or seven feeds three-hourly. Baby put to breast, if condition allows, two or three days after operation.

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5	1 dr.	ditto.
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6	1 dr.	ditto.
6½	1 dr.	ditto.
7	1 dr.	ditto.
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8½	2 dr.	ditto.
9½	3 dr.	ditto.
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15½	1 oz.	ditto.
17½	1 oz.	ditto.
19½	1 oz.	ditto.
21½	1 oz.	ditto.
23½	1½ oz.	ditto.
25½	1½ oz.	ditto.
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7½	1 dr.	ditto.
9	3 dr.	Breast-milk.
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36½	1 oz. 6 dr.	ditto.
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Then six or seven feeds three-hourly. Baby put to breast, if condition allows, two or three days after operation.

part of the operation, are prevented from coming in contact with the suture-line. This latter may be dabbed frequently with a gauze sponge soaked in acriflavine 1/1000 in paraffin emulsion, or may be dusted lightly with penicillin-Sulphathiazole powder.

Immediately after the operation the baby is fed with the appropriate quantity of breast-milk, which has been drawn off, or bottle-milk if the former is not available, by means of a tea-spoon, the sides of which have been hammered together so that a narrow, deep trough is formed. With this spoon the milk is poured into the side of the baby's cheek. On the fourth day the baby may be put back on to the breast and can suckle satisfactorily with the Logan's bow in place.

Cleft Palate

In contradistinction to hare-lip the after-treatment of operations for cleft palate is unimportant. The best way of treating them is to leave them alone. " Sloughs ", which are really moist scabs, should not be syringed away and, if the child evinces a desire to talk, he need not be discouraged. After the nausea of the immediate post-anæsthetic period has abated, the child may return to his former diet. Morphia is withheld if possible because it makes the mucus in the mouth ropy and difficult to swallow; also it tends to diminish the respiratory excursions and so conduces to chest complications.

remove him from hospital after the stitches have been taken out on the eighth day, provided that the home conditions are satisfactory. Modern children's hospitals are so designed that glass barriers minimise the liability to cross-infection and it is to be hoped that, in such institutions and with due precaution, this particularly lethal complication may be controlled.

Acute Intussusception

The after-treatment of this operation conforms to the general principles laid down above. If the intussusception has been satisfactorily reduced the prognosis is very good. The child can be encouraged to take sips of boiled water from the time that he comes round from the anæsthetic and may be put back on the breast within six hours of the operation. The same precautions must be taken to guard against enteritis as after operations for pyloric stenosis, but in the older patient who suffers from intussusception the liability to this complication is not so great.

III. PLASTIC OPERATIONS

Hare-Lip

The repair of a hare-lip may break down because of tension on or infection in the suture-line.

Tension is relieved by means of Logan's bow or one of the modifications of this bow such as Denis Browne's (Fig. 61), which can be tightened This bow should be so fixed that the two halves of lip are positively forced together and the whole lip is pursed. The Denis Browne modification allows the purchase to be tightened each day so that all possibility of tension is taken off the suture-line until it has healed. Sutures are removed on the sixth day and the bow is discarded on the fourteenth. Infection is prevented by lightly packing the nostril or nostrils in relation to the repair with a pledget of dry cotton-wool. This is changed when it becomes moist and a fresh dry pledget inserted. In this way nasal discharges, which are always increased as a result of the intranasal

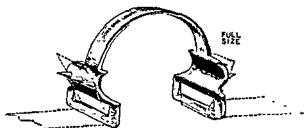


FIG 61 —Denis Browne's modification of Logan's bow.

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CHAPTER XIV

REHABILITATION

To be sick is to enjoy monarchal prerogatives. Compare the silent tread and quiet ministry, almost by the eye only, with which he is served—with the

to the elbow-chair of convalescence, is a fall from dignity, amounting to a deposition

How convalescence shrinks a man back to his pristine stature! Where is now the space, which he occupied so lately, in his own, in the family's eye? Perhaps some relic of the sick man's dream of greatness survives in the still lingering visitations of the medical attendant But how is he, too, changed with everything else? Can this be he—this man of news—of chat—of anecdote—of everything but physic—can this be he, who so lately came between the patient and his cruel enemy, as on some solemn embassy from nature, erecting herself into a high mediating party?—Pshaw! 'tis some old woman.

The Essays of Elia

I. GENERAL PRINCIPLES

Rehabilitation is the re-education of a patient during his convalescence. It may be begun on the day following an operation or it may have to be deferred for an indefinite period depending upon his state and the nature of his disability. The great value of rehabilitation is that, with the exception of most forms of physiotherapy, it demands the active co-operation of the patient so that he develops an interest and partnership in his own recovery.

There is a stage in most serious disorders or in the recovery from most major operations, when the patient is ministered to and when nothing is demanded from him except that he tolerates his disease with as much fortitude as he can muster. Later, when he is not so much diseased as disabled, the problem of rehabilitation is to restore him as nearly as possible to normal in the shortest possible time. The days are gone when all the waking hours of a convalescent patient were devoted to sitting in front of the ward fire with a pack of cards or listening to the wireless. At this stage he is expected and must be encouraged to take a hand in his recovery; he must be made to realise that his job is to get well and that the speed with which this is attained depends largely on his own exertions.

There are broadly two types of patient: those who may be expected to make a complete recovery and return to their former occupations, and those who will never completely recover and who may have to

learn fresh trades or acquire fresh interests and habits of mind. The objects of rehabilitation are somewhat different in the two types. In the first the importance of this treatment is mainly economic. The waste of man-power and of hospital accommodation, together with the additional insurance benefits which have to be paid when convalescence is needlessly prolonged, must cost this country millions of pounds each year in hard cash. It is the purpose of rehabilitation to reduce this wastage to the minimum. In the second type of patient the importance is partly economic but mostly individual. The patient must be saved from becoming a dead-weight on the community, not so much perhaps because of the financial loss entailed, but to restore his self-respect and to afford him enjoyment and the means of attaining happiness.

The successful application of rehabilitation demands, as has been already mentioned, a helpful and co-operative attitude on the part of the patient. The encouragement of such an attitude can start from the earliest days after an operation and often long before rehabilitation itself can be practised. Thus by their demeanour the doctor and the nurse can generate an optimistic spirit and encourage that will to get well without which the splendid palaces of rehabilitation, which it is hoped may be erected in the future, will be built in vain. Earlier in this book stress was laid upon the importance of fresh air and a change of scenery; it must not be forgotten, moreover, that for certain patients a week at Margate or Blackpool, amidst the apparently unhygienic but undoubtedly nostalgic scenes of former glories, may prove of greater benefit than a visit to some splendidly appointed home in the Yorkshire moors.

The instruments of rehabilitation are Physiotherapy, Occupational Therapy and Remedial Exercises.

II. PHYSIOTHERAPY

It is because of its passive quality that physiotherapy, which is here used in its restricted sense, has lately fallen somewhat from grace. Most forms of physiotherapy are pleasant and soothing, so that the patient resigns himself to the delights of treatment and is less inclined to make the effort himself. If we bear in mind this potential danger of physiotherapy, it is a most valuable therapeutic measure.

It will be impossible in a short account to describe in detail the indications for, or the technique of, the administration of physiotherapy, but certain general principles can be discussed. Physiotherapy implies the therapeutic application of a number of physical agencies, such as

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There is a stage in most serious disorders or in the recovery from most major operations, when the patient is ministered to and when nothing is demanded from him except that he tolerates his disease with as much fortitude as he can muster. Later, when he is not so much diseased as disabled, the problem of rehabilitation is to restore him as nearly as possible to normal in the shortest possible time. The days are gone when all the waking hours of a convalescent patient were devoted to sitting in front of the ward fire with a pack of cards or listening to the wireless. At this stage he is expected and must be encouraged to take a hand in his recovery; he must be made to realise that his job is to get well and that the speed with which this is attained depends largely on his own exertions.

There are broadly two types of patient: those who may be expected to make a complete recovery and return to their former occupations, and those who will never completely recover and who may have to

disabilities. Briefly it is of value in fractures, palsies and certain conditions associated with fibrosis, provided that it is always ancillary to, and never allowed to take the place of, active movements when they are possible. Of all forms of physiotherapy massage is the most likely to mesmerise the patient into soporific resignation. Patients generally expect it and many enjoy it, but doctors should use it with discretion.

Deep X-ray Therapy

Lastly the circulation may be increased by means of deep X-ray therapy. This method is unlikely to be used in post-operative or post-traumatic cases because the effect is not felt until some weeks after the application of the rays. It is of particular value in such chronic disorders as osteoarthritis. The great virtue of this form of treatment is due to its very great powers of penetration and its prolonged effect.

PASSIVE MOVEMENTS

Passive movements are movements made on a joint other than by the muscles acting on that joint and they have been fully discussed in the chapter on fractures, where a distinction was drawn between "passive" and "auto-passive" movements. Manipulation, which is only passive movement carried a stage further, is also discussed in the same chapter, where its value and dangers are assessed. It may, however, be emphasised once more that passive movements must always give way to active movements as and when the latter become possible.

Electrical stimulation of a muscle, either directly (by means of galvanism) or through its nerve-supply (by means of faradism), may be mentioned here in that it is a form of passive movement applied to a muscle. The field for this form of therapy is in the treatment of immobilised or paralysed muscles. Here again a volume of detailed description must give way to the enunciation of a few principles. Muscles must, if possible, be *moved*. If a muscle or group of muscles will contract voluntarily no form of physiotherapy is necessary as far as they are concerned. If they will not contract voluntarily, faradic stimulation should be applied so that the muscle contracts as a result of stimulation of its motor nerve. If faradic stimulation is ineffective, galvanic stimulation is applied to the muscle itself. Similarly during the course of recovery, as soon as faradic stimulation becomes effective, galvanic stimulation is discarded, and faradic stimulation gives way in turn to voluntary movement as *soon* as the latter becomes possible.

heat, light and electricity. It can serve to increase the circulation in a part, to mobilise paralysed or stiff structures, and to promote recovery by means of artificial sunlight.

Methods of Increasing the Circulation

Dry Heat

This may be effected by the radiations from an electric cradle or by subjecting the part to the heat of an electric fire. These measures will increase the circulation at the surface, but they have poor penetrating powers. *Hot Wax Baths.*—These are particularly useful in increasing the circulation of the extremities. *Infra-red Rays.*—In order to affect deep-seated structures infra-red rays, which penetrate the tissues, are to be preferred to other forms of radiant heat.

Diathermy

The best means of heating deeply situated structures, however, is by diathermy. In this method of treatment a different principle is used. An electrical circuit is set up by applying two conductors to the body surface and using the tissues between as a dielectric. As the body tissues are not perfect insulators but allow some current to leak through, the dielectric (in this case the tissues themselves) is heated irrespective of its distance from the surface. Diathermy is of special value in chronic disorders such as arthritis. It should never be used in neuritis, as the heat generated in the nerve increases the circulation and therefore the tension within the relatively rigid nerve sheath and so makes the pain worse. For the same reason it should be used only with the greatest care in those parts of the body in the region of large nerve trunks or plexuses.

Short-wave Diathermy

Short-wave diathermy, or the passage of wireless waves of about 8 metres in length through the body, is indicated in acute and subacute infections, particularly with such staphylococcal infections as carbuncles. The effect of short-wave diathermy is due not only to its heat-generating properties, which are less than those of ordinary diathermy, but to some unknown specific action upon inflamed tissues.

Massage

This is another method by which the circulation is stimulated and traumatic exudates are absorbed It will not be possible here to discuss the theory of massage or to detail the indications for its use. Massage has been mentioned hitherto in this book in connection with individual

have rejected as being impossible or too painful. Thus if a patient with a stiff ankle is given a treadle-worked fret-saw to operate, the absorption in the task in hand will so take his mind off his ankle that he unconsciously uses the latter to an extent which he would never have attained by conscious endeavour. Lastly with patients who can never be fully restored to health, occupational therapy can be used to teach them new trades, to encourage them to rely once more upon themselves and to give them a sense of purpose, without which life becomes intolerable.

Occupational therapy was practised in this country after the Boer War and the obvious benefits deriving from this form of treatment resulted in the foundation of the "Lord Roberts Workshops for Disabled Soldiers". During and after the World War of 1914–1918 the late Sir Robert Jones developed and encouraged occupational therapy, so that centres were formed in different parts of the country. To-day, not only the Services but Industry has appreciated the value of this form of treatment and centres such as Berry Hill (described by Nicoll in the *Brit. Med. J.*, 1941, 1, 501), Crewe and Greenwich are being formed in increasing numbers to the mutual benefit of employee and employer. An equipped centre is essential for the successful practice of occupational therapy, not only from the point of view of the apparatus required (card-board, glue, paper, paints, wood, tools, benches and even lathes), but so that a spirit of rivalry and mutual interest can be generated. Men particularly are shy of making what they regard as "fools of themselves" by indulging in such trivialities until they see the enjoyment and benefit which their companions derive from these exercises.

The measures employed are becoming increasingly varied. For women there is needlework, woolwork, weaving, carpet-making and toy-making, whilst the more active can do gardening or work in the laundry or canteen. Men are best employed in a workshop where they can indulge in carpentry and fret-work, model-making and metal-work, progressing as recovery allows to gardening, digging, agriculture, log-sawing and heavy manual labour of all sorts.

An important principle in occupational therapy, which was mentioned in the chapter on fractures, is to design the programme with regard to the man's normal work. His occupation should then be such that the muscles which he employs at his work are utilised, but against diminished resistances and, to begin with, for short periods only.

Recreations play an important part in this type of re-education, swimming, basket-ball, football, deck-tennis, squash and bicycling being of special value.

BALNEOTHERAPY

Treatment of a patient by immersing the whole or part of the body in a bath of water and encouraging movements in a fluid medium is a form of assisted movement which, while not coming strictly under the heading of passive movement, may be mentioned here. If the bath is warm, stiffness and pain are alleviated, but the principal effect of balneotherapy is that much of the load of gravity is removed and movements are performed steadily and smoothly against a gentle resistance. Teaching an old paraplegic patient to walk is rendered easier by allowing him to pick his way, submerged up to the axillæ in water, and supported by a rope or bar at the side of the bath.

ARTIFICIAL SUNLIGHT

This is usually given in the form of ultra-violet rays from a mercury-vapour lamp. The purpose of generalised ultra-violet light is best described in terms which are commonly used by the layman—it acts as "a tonic to the system". How it acts and wherein lies its undoubted benefits are not precisely understood. It will produce pigmentation of the skin and the psychological result of this has as satisfactory an influence on the patient's well-being as the possession of a new hat has on a woman. It stimulates the synthesis of ergosterol and so renders available a liberal supply of Vitamin D, and it is said to increase metabolism. Despite this last effect, weight is usually put on during a course of artificial sunlight, the appetite improves and the resistance to infection is enhanced. Care must be taken not to prescribe this form of treatment in cases suspected of phthisis, as ultra-violet radiation may light up a quiescent focus. Ultra-violet light may also be used locally and is of value in the treatment of granulating wounds. Its effects in this type of therapy are said to be an increase of the circulation, a stimulation of the resistance of the tissues to infection and a direct bacteriocidal action on the infecting organisms.

III. OCCUPATIONAL THERAPY

Occupational therapy has three main functions. In the first place it gives the patient something to do and so whiles away the time and prevents the stagnating effects of boredom, forestalling the possible development of neuroses which mental inactivity encourages. This effect is particularly important in the after-treatment of head injuries, in which neurotic manifestations are common. In the second place, by giving the mind an interest, occupational therapy subconsciously allows movements to be performed which the conscious mind would

Cases	*Weeks*	*Management*
Cartilage Cases	* (Until walking does not interfere with the progressive absorption of excess synovial fluid)	Quadriceps exercises for five mins. each hour and "flicking" the patella at all times.
	* 1	Special Knee Grade I
	* 2	Special Knee Grade II
	* 3	Special Knee Grade III
Hæmorrhoids	1	Bed
	2	Up
	3	Grades I and II
	4	Grades II and III
Above-knee Plasters	Quadriceps exercises against increasing weight and under supervision for five minutes four times a day.	
Below-knee Plasters	To use the leg for walking as much as possible.	
Cases out of Plaster and in Unna's Paste	1	Grade I
	2	Grade II
	3	Grade III
Finger Cases	Active movements of all the joints of all the fingers at all times of the day and once a day under supervision.	
	1	Grade I
	2	Grade II
	3	Grade III
Inguinal Herniæ	1	Bed
	2	Bed
	3	Bed
	4	Up
	5	Grade I (omitting exercise 8)
	6	Grade II (omitting exercise 8)
	7	Grade III (omitting exercises 2, 10, 12)

IV. REMEDIAL EXERCISES

Of the three types of rehabilitation discussed, remedial exercises are perhaps the most important. They depend for their success to a certain extent upon the personality of the instructor, but largely upon the patient's own exertions. They should, if possible, always take place in the open air and should be performed in groups or classes; even a group of two is better than a solitary patient struggling manfully but wearily through a programme of exercises without the stimulus of competition or emulation.

Before describing the various stages of remedial exercises it will be necessary to consider when a patient is fit to embark on such a course. The age of the patient must be considered, and in some patients over the age of fifty, exercises must be conducted with great care and consideration. A decision can be made only by a doctor who is familiar with, and himself has performed, the exercises and who therefore knows the precise effort involved; but as a preliminary guide I have included below a scheme which was found satisfactory in a military hospital, and which I devised for the guidance of the rehabilitation officers. The exercises described in the following table are such as can be performed in any large room and no special equipment is required; where, however, a fully equipped centre is available the scope is wider. In general, the less these activities are made to resemble stereotyped "P.T." the better.

Usually a patient may start on Grade I when he has been out of bed for one week, although after a long illness this may be too short a period, and after a short one it may be too long. The following are typical examples:

Cases	*Weeks*	*Management*
Appendicectomies	1	Bed
(uncomplicated by	2	Up
peritonitis)	3	Grade I
	4	Grade II
	5	Grade III
Varicose Veins	1	Bed
(ligature of internal	2	Up
saphenous vein with	3	Up
injection of the distal	4	Grades I and II
segment)	5	Grades II and III

Agility and Games

(4) Mental Agility. Variations of " O'Grady says " : Commands are obeyed only if preceded by " O'Grady says ". Alterna- [illegible] [illegible]llowed by " do this " and are [illegible]

(5) [illegible] -ball. Passing the ball from one man to the next in a file one behind the other. Races between files. The ball may be passed over the head, sideways to the right or left, or between the legs.

Balance

(6) Stand so that the abducted arm fully outstretched supports the trunk against the wall. Outside leg and arm raise forward and lower. Arm raise forward and leg backward (watch for correct body-position). Change to opposite arm and leg.

Spine

(7) Correct crook-sitting—hands placed easily under thighs, trunk upright (chin in), toes just touching floor. Then (*a*) Relax head on to knees.
(*b*) Stretch up.

If unsupported position is too much strain, lean against wall.

Abdominal

(8) Crook-sitting—relax to back-lying. Start relaxation in lumbar spine, rolling each part of the spine along the floor until the head comes to rest. Raise the trunk to the original position by reversing the procedure and using the help of the hands pressed on to the floor.

Final

(9) Walking—re-education. Free arm-swinging.

(10) Back-lying—deep breathing.

GRADE II

Introductory

(1) As in Grade I.

Regional

(2) Back-lying. Contract and relax muscle-groups individually as before but rhythmically.

(3) Prone-lying. Hands under forehead as before, chest-lifting with inspiration and lowering with expiration. Contract transverse shoulder muscles and lift elbows and hands slightly off the ground, then lower. Repeat rhythmically.

Agility and Games

(4) Games as in Grade I, also :
Mental Agility. " Reaction-touch ". A previously given command is obeyed as soon as the man is touched The eyes should be kept closed. " Clock-game ". The class is arranged in files and the first man of each file is given a piece of chalk On the word of command each runs forward a given number of paces and draws a circle on the floor with the chalk He then runs back and hands the chalk to the next man, going himself to the back of the queue The second man fills in the figure one on the clock and returns the chalk to the third man, who fills in the figure two, and so on. When the figures are completed the hour-hand and then the minute-hand are drawn in. The aim is to draw the best clock in the quickest time.

(5) Ball-games. More-strenuous games with the football.

Cases	*Weeks*	*Management*
Inguinal Herniæ (cont.)	8	May return to sedentary occupation
	9	
	10	
	11	
	12	May return to manual labour

Instead of exercises I[8], II[8] and III[8,10,12], hernia cases should do "frog jumps"—little springs off the ground in the squatting position. These contract and exercise the abdominal musculature but with the thighs flexed on to the abdomen, in which position there is no strain on the inguinal canal.

Femoral Herni–	1	Bed
	2	Bed
	3	Up
	4	Grade I
	5	Grade II
	6	Grade III
	7	May return to sedentary occupation
	8	
	9	
	[illegible]	May return to manual labour

GENERAL EXERCISES

(Modified from those used by Major Paterson, R.A.M.C., Western Command. Specialist in Physical Medicine Eaton Hall, December, 1941.)

GRADE I

Introductory

(1) [illegible] the back.

Regional

(2) Back-lying—relaxation on expiration. Contraction of groups of muscles followed by relaxation
(a) arm, (b) leg, (c) abdomen and (d) neck.
(3) Prone-lying—(hands open, right on left, forehead laid on both). Contraction of all back muscles without lifting the chest off the floor.

(b) A number of commands are given and on the word "go" these commands are carried out. Thus "Stand to attention; right turn; take three paces backwards; about turn; take two paces forward; halt" . . . "Go."

(8) Ball-games More-strenuous games with the medicine-ball. Net-ball.

Balance

(9) As in Grade II[4], but done rhythmically with sudden command to stop. Position held.

Regional

(10) Back-lying. Trunk-raising to forward-reach.
(11) Sitting. Trunk-rotating with legs flat on the floor.
(12) Back-lying. Alternate leg raised vertically and then fully adducted so that the toes touch the ground on the opposite side.

Final

(13) Walking. Free arm-swinging.
(14) Standing. Full deep breathing.
These cases may go for a four-mile walk daily.

SPECIAL KNEE EXERCISES (may be combined with General Exercises)

GRADE I

Introductory

(1) Rub and slap knee for warming up.
(2) Sitting upright on a couch with legs dangling. Alternate leg-swinging, backwards and forwards, raising each leg alternately ("scissors").

Regional

(3) Sitting upright on the ground.
Hold sound leg then weak leg in extension with ankle dorsi-flexed.
(4) Back-lying Contract quadriceps with dorsi-flexion of ankle.
(5) [illegible] the ground.
(6) [illegible] ls, held palm to palm,
(7) [illegible] s braced back. Reach

GRADE II

Introductory

(1) & (2) As in Grade I.
(3) Repeat as in Grade I, holding position longer.
(4) Back-lying Alternate leg-raising, toe pointed. Increase range of movement to right-angles
(5) Back-lying Bend knee to chest, extend and flex knee; lower
(6) Stand with outstretched arms supported. With knees and feet together, heels raise and knees half-bend. Rise and brace knees back strongly. Repeat rhythmically.
(7) Facing wall-bars Grip bar, place weak knee on successively higher rungs
(8) Kneeling, thighs vertical; change to kneel-sitting and return to original position.
(9) Walking four paces with heels raised, then four paces with knees raised alternately.

Balance

(6) As in Grade I, but without support.

Spine

(7) Crook-sitting, back supported. Arms raise above the head. Relax to head on knees and arms to the side. Stretch up to original position. Repeat rhythmically.

Abdominal

(8) Crook-sitting. Uncurl as before to back-lying. In this position try to shorten each leg in turn by tilting the pelvis first to one side and then to the other, with the knees kept straight.
(9) Back-lying. Rotate head rhythmically to right and left.
(10) Back-lying. Bend each knee in turn and press on to the abdomen. Flex and extend the ankle. Extend and flex the knee.

Final

(11) Walking. Re-education
(12) Standing. Deep breathing.
These cases may go for a two-mile walk daily.

Grade III

Introductory

(1) Quick march with heels-raising Marking time with opposite knee and arm raised forward. Marching with opposite knee and arm raised forward. Marking time at the double.

Regional

(2) Back-lying. Bend knee to chest; straighten out leg vertically, lower slowly Repeat with other leg.
(3) Prone-lying. (Starting position as in Grade I.) Trunk-raising with [illegible] first of one hip-joint, [illegible]
(4) [illegible] -lomen and clasp with [illegible] ackwards (free from [illegible] with other leg.
(5) [illegible] hanging down, then slowly extend.
(6) Crouch-position. Thrust buttock into the air by straightening the legs, keeping the hands palms downwards on the ground.

Agility and Games

(7) Mental Agility.
(a) The class lines up in files as before The front man in each file has a piece of chalk The instructor calls out a number greater than ten and less than a hundred. The first player then runs forward [illegible] correct result.

APPENDICES

APPENDIX I

ENEMATA

1. *Gruel.*—Fine oatmeal ½ ounce and water 12 ounces. Boil for twenty minutes and strain. When cooled to body-temperature add olive-oil 5 ounces. *For painful anal conditions.*

2. *Saline.*—One pint of warm normal saline. *For colostomies.*

3. *Soap.*—Soft-soap 4 ounces to a pint of warm water. *Routine.*

4. *Treacle.*—Black treacle 5 ounces to a pint of warm water. *Obstinate constipation.*

5. *Ox Bile.*—Fresh ox bile 4 drachms to not more than ½ pint of a solution made up as for a soap enema. *Flatulent distension.*

6. *Turpentine.*—Turpentine 1 ounce to a pint of soap solution. *Flatulent distension and paralytic ileus.*

7. *Compound Turpentine.*—

Magnesium sulphate
Sodium sulphate
Glycerine
Turpentine } aa. 2 ounces

mixed with water up to 12 ounces. Just before administration the volume is made up to a pint by the addition of boiling water. *Fæcal impaction.*

8. *Glycerine.*—Glycerine 1 drachm to water 1 ounce. *Infants.* Glycerine 1 ounce to water 4 ounces. *Children* aged eight.

Grade III

Introductory

(1) & (2) As in Grade I.
(3) As in Grade II[6] but without support.
(4) Heel-walking and toe-walking.
(5) Forward jump from the standing position, landing with full knees-bend.
(6) Standing. Knee bent to chest with other knee braced back.
(7) Giant's strides.

In addition to these exercises and throughout, quadriceps drill must be practised

These consist in:

(*a*) Back-lying and raising the leg a foot off the ground and lowering Gradually increase the effort by hanging weights on the ankle.
(*b*) "Scissors". The above exercise done rapidly with alternate legs.
(*c*) Spontaneous contraction of the quadriceps at all times throughout the day by "flicking" the patella.

Special exercises are also available for the neck, chest and abdomen, the shoulder-girdle, elbow, wrist and fingers, the hip, ankle and foot; but suitable programmes for these regions can readily be devised by anyone with an elementary knowledge of anatomy and they are not so commonly employed as those detailed above

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The following articles may be referred to for a full account of the principles and practice of rehabilitation:

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Late Rehabilitation of the Injured	Miller, A	*Brit Med J.*	1942, **2**, 209
Rehabilitation of Injured Miners . . .	Colson, J. H C	*J Chart Soc Mass*	1942, **27**, 93

Calorie Value of some Common Foods not Included Above

(Adapted from *Applied Physiology*, Samson Wright, 1940, Oxford. Oxford University Press.)

	Food	*Calories per 1 oz.*
Fruit	Bananas	23
	Grapes	20
Vegetables	Beans	26
	Parsnips	18
Fish	Kipper	31
	Plaice	14
	Salmon	43
Meat	Ham	60
	Mutton	59
	Pork	72
	Veal	66
Cereals	Biscuits	135
Miscellaneous	Cream cheese	100
	Chocolate	140
	Jam, syrup, honey, marmalade	85
	Cream	60

APPENDIX II

THE NUTRIENT VALUE OF COMMON FOODS

[Adapted from a paper by A. L. Bacharach (*Food*, 1940, **10**, 29), and reproduced by permission of the editor.]

				Grams				*Milligrams*		*International units*		*Milligrams*	
Food	*Normal Portion*	*How Consumed*	*Calories*	*Protein*	*Fat*	*Carbohydrate*	*Calcium*	*Iron (available)*	*Phosphorus (available)*	*Vitamin A*	*Vitamin D*	*Aneurine*	*Ascorbic Acid*
Milk .	1 pint	As bought or heated	380	18	22	26	680	0·4	240	1200	10	0·3	10
Bread (white)	4 oz	As bought	290	9	1	61	26	1·0	80	0	0	0·07	0
Bread (wholemeal)	4 oz	As bought	260	10	2	50	35	2·4	150	trace	0	0·3	0
Potatoes	4 oz	Boil'd in jackets	110	2·5	0	23	5	0·6	26	0	0	0·12	20
Butter or margarine	1 oz	As bought	225	0	24	0	4	0	7	500	30	0	0
Cheese (Cheddar)	2 oz	As bought	240	14	19	0	460	0·3	310	1000	8	0	0
Egg .	One 2 oz	Boiled	80	6	6	0	30	1·5	120	250	150	0·05	0
Oatmeal .	2 oz	As porridge	245	7·5	5	41	31	2·4	120	0	0	0·45	3
Lentils (dried) .	2 oz	Soaked & baked	180	13	0	31	20	2·5	8·5	150	0	0·025	1·5
Cane Sugar	1 oz	As bought	115	0	0	28	0	0	0	0	0	0	0
Bacon (streaky)	1 oz	Fried	150	7	12·5	0	15	0·3	70	0	0	0·3	0
Beef (lean)	2 oz	Roast	130	15	7	0	3·5	0·3	160	20	0	0·03	0
Liver .	1 oz	Fried	80	8·5	4·5	1	2·5	5·9	155	5000	0	0·12	10
Herring	4 oz	Baked boned	200	18	14	0	60	1·6	360	700	400	0·02	20
Cod	2 oz	Steamed skinned and boned	40	8	0·5	0	7	0·2	110	0	0	0·02	5
Tomato	One 2 oz	As bought	8	0·5	0	1·5	8	0·2	12	1700	0	0·02	11
Orange	One 7 oz	As bought peeled	60	1	0	13	62	0·6	34	200	0	0·2	40
Apple .	One 3½ oz	As bought skinned no core	40	0	0	10	3	0·2	10	0	0	0·1	2
Cabbage	2 oz	Boiled inner leaves	4	0	0·5	0·5	17	0·2	18	500	0	0·09	2
Carrot (old)	2 oz.	Boiled	12	0·5	0	2·5	21	0·2	9	4000	0	0·1	2

Calorie Value of some Common Foods not Included Above

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Bread (wholemeal)	4 oz	As bought	260	10	2	50	35	2·4	150	trace	0	0·3	0
Potatoes .	4 oz	Boil'd in jackets	110	2·5	0	23	5	0·6	26	0	0	0·12	20
Butter or margarine	1 oz	As bought	225	0	24	0	4	0	7	500	30	0	0
Cheese (Cheddar)	2 oz	As bought	240	14	19	0	460	0·3	310	1000	8	0	0
Egg .	One 2 oz	Boiled	80	6	6	0	30	1·5	120	250	150	0·05	0
Oatmeal	2 oz	As porridge	245	7·5	5	41	31	2·4	120	0	0	0·45	3
Lentils (dried)	2 oz	Soaked & baked	180	13	0	31	20	2·5	8·5	150	0	0·025	1·5
Cane Sugar	1 oz	As bought	115	0	0	28	0	0	0	0	0	0	0
Bacon (streaky)	1 oz	Fried	150	7	12·5	0	15	0·3	70	0	0	0·3	0
Beef (lean)	2 oz	Roast	130	15	7	0	3·5	0·3	160	20	0	0·03	0
Liver	1 oz	Fried	80	8·5	4·5	1	2·5	5·9	155	5000	0	0·12	10
Herring .	4 oz	Baked boned	200	18	14	0	60	1·6	360	700	400	0·02	20
Cod	2 oz	Steamed skinned and boned	40	8	0·5	0	7	0·2	110	0	0	0·02	5
Tomato	One 2 oz	As bought	8	0·5	0	1·5	8	0·2	12	1700	0	0·02	11
Orange	One 7 oz	As bought peeled	60	1	0	13	62	0·6	34	200	0	0·2	40
Apple	One 3½ oz	As bought skinned no core	40	0	0	10	3	0·2	10	0	0	0·1	2
Cabbage .	2 oz	Boiled inner leaves	4	0	0·5	0·5	17	0·2	18	500	0	0·09	2
Carrot (old)	2 oz	Boiled	12	0·5	0	2·5	21	0·2	9	4000	0	0·1	2

"He stated that on the morning of January 8th, 1941, whilst in the employ of Messrs. Brown of Bermondsey Street, he was working a Schulbred's mortar-mixer which entailed standing on a plank three feet from the ground and pedalling with the right foot. Whilst engaged in this work he slipped off the plank and 'twisted his left ankle'. He was able to get up off the ground but could not put any weight on the left foot because of pain. He reported this accident at once to the foreman, who sent for an ambulance and he was taken to St. Bride's Hospital, Lambeth. Here he was X-rayed and found to have sustained a fracture about the ankle-joint. Within an hour of admission he was given a general anæsthetic, and the leg was put in plaster from the metatarsal heads to the tibial tuberosity (from the toes to the knee-joint). The following day a 'Guy's sole' was applied to the plaster and he was discharged, being told to report again in three weeks' time for a further X-ray examination. Accordingly on January 30th, 1941, he again visited St. Bride's, where a further X-ray examination was made and the plaster was changed. During the interval he had been able to walk about in the plaster cast quite comfortably as soon as he acquired confidence. On March 6th, according to instructions, he again visited St. Bride's, where a further X-ray examination was made and the plaster cast was removed. An Unna's paste bandage was applied in its stead, and the patient was instructed to keep this on for a fortnight. In the meanwhile he was told to exercise the ankle-joint and to use the leg as much as possible for walking, but was warned that this must stop short of producing pain or throbbing in the part. He appears to have followed these instructions conscientiously and can now walk about three miles, after which the ankle becomes painful and swollen, and he is forced to rest. This has been particularly so since the Unna's paste was discarded on March 20th The patient seems genuinely anxious to return to work, but he is afraid that his leg would not stand up to the eight-hour shift which is required of him."

A note is then made of previous diseases or injuries and any relevant aspect of the family history. It is important that these should be included, as in some cases pre-existing disease may have an important bearing on the case. For instance, chronic bronchitis is a *contributory* cause of hernia. For the same reason the examination should include the heart and lungs with a note on the blood-pressure, and results of analysis of the urine are necessary for a full report. Exhaustive examination of the organs is not expected, but such signs as can be detected with the aid of the stethoscope should be reported.

In examining the part itself great importance is attached to

APPENDIX III

WRITING REPORTS

INSURANCE companies frequently require reports on cases injured as a result of a road accident or while at work. Some companies provide a form upon which the report may be filled in and in that case answers to specific questions are required. Such a report is a legal document and can be produced in a court of law, where the doctor may be examined and cross-examined on it. It is therefore necessary to prepare these reports with the greatest care, and the assistance of colleagues or the views expressed in text-books are not lightly to be despised. Scientific terms if used in such a report—and there is not the same objection to the use of these in reports as there is in the witness-box—must be accompanied by explanatory parentheses. Thus:

"The inferior radio-ulnar joint (a small joint just above the wrist)."

The conventional fee for such a report, including a prognosis, is two guineas, and this is properly payable in advance.

The report should begin with a note of the place of examination, the date, the patient's name, age, occupation and address:

"422, HARLEY STREET,
"W.1.

"On April 24th, 1941, I examined John Smith, aged 45, a bricklayer of 52, Petersfield Court, Southwark, at the above address."

There follows a brief description of the nature of the accident. The patient is inclined to load his account with a wealth of technicalities and these, however important they may be to the lawyer, can usually be briefly summarised by the doctor. It is important later, however, to state whether the injury was in your opinion sustained in the manner described, and an account must be given as to what happened immediately after the accident. In cases of head injury it is necessary to state if the patient can remember up to the time of the accident (retrograde amnesia), how soon after the accident he has a clear recollection of events and if he vomited. The patient may also be able to state if bleeding took place from the nose or ears. Thus:

"*Movements.*—Left knee—full.
Left ankle—dorsi-flexion limited by a few degrees; plantar-flexion limited by 5°–10°.
Subastragaloid joint (the joint immediately below the ankle)—inversion and eversion severely limited.

"*Measurements.*—	*Left.* *Inches.*	*Right.* *Inches.*
Instep (2 inches from internal malleolus) . .	10½	10½
Ankle-joint	12½	11
Calf muscle (8 inches above internal malleolus) .	14½	16

"The patient appears to have sustained a fracture about the ankle-joint which could have occurred in the manner described. Clinically the fracture seems to be soundly healed and in good position, but there are limiting adhesions in a neighbouring joint and some wasting of the muscles of the calf."

"**Prognosis**

"This can assume various forms. The words 'in my opinion' should precede each example.

"1. The patient will never again be fit for work of any sort, and settlement by compensation in a lump sum is advised.

"2. The patient will never again be fit for full work but will be fit for light work in a month. Settlement by compensation in a lump sum is advised at the end of this period.

"3. The patient is now fit for light work (or will be fit for light work in three weeks), and for full work in three months. (The fact that there is no 'light work' in that particular patient's trade is not the immediate concern of the doctor. It is for the court to take this into account.)

"4. It is not possible at this date to give a useful prognosis and re-examination is suggested in four months' time.

"5. The patient should be advised to undergo an operation for amputation of his fingers (manipulation of his back, nerve suture, etc., etc.). At present he is fit only for light work, and will not be fit for full work at least until this operation has been performed. I suggest another examination two months after the operation for a further assessment of prognosis."

Thus to return to our example:

"In my opinion a manipulation of the ankle-joint is advisable, after which he should be fit to return to full work in about two to three weeks, although a further examination should then be made."

measurement. It is only by this means that progress can be gauged, and the subjective sensations of the patient given objective expression. Thus the range of movement of joints must be given in degrees or in degrees short of the complete range. The circumferences of limbs are measured at stated distances from bony points and compared with the other side to determine the extent of wasting or swelling, and the measurement and exact site of scars must be noted. Points of tenderness are precisely localised, the skin-temperature roughly assessed and the colour of a limb described. In lower-limb and back injuries the patient must be seen to walk so that the nature and extent of limping can be ascertained.

Our report should therefore continue :

" The patient has suffered from the usual childish complaints and had an appendicectomy performed in 1928 for acute appendicitis. He has had no other illnesses, and there is nothing relevant in his family history.

" Examination

" The patient is about six feet tall and says that he weighs fourteen stone. He is powerfully built and of plethoric type.

" Heart—normal.

" Lungs—there are some râles at the right base, but no other signs. The patient says that he has lately been suffering from a bad cold.

" Blood-pressure—160/94.

" Urine—specific gravity 1014. No blood, pus, sugar or albumen.

" THE LEFT LEG

" The patient walks with a slight limp with the dip towards the unaffected side. (This apparently irrelevant medical technicality might serve to unmask a hysterical or malingering limp.) On standing bare-footed on a firm surface, there is no dropping of the arches. The left ankle is swollen, but the colour of the skin of the foot and the temperature of the part suggest that the circulation is satisfactory. The left calf muscles appear wasted. On the outside of the ankle-joint 1½ inches above the external malleolus (outside ankle bone) there is a bony ridge which is free from tenderness. Immediately below the external malleolus there is a puffy tender swelling, and there is a similar tender swollen area immediately below and behind the internal malleolus (inside ankle bone).

Precedence of Courts

Should a doctor receive a subpœna to attend two different courts on the same day, a criminal case always takes precedence over a civil case which can be deferred; and a Coroner's court takes precedence over all others in this respect. He should therefore attend the court which takes precedence and address a letter to the president of the other court informing him of the situation. A subpœna is a guarantee that the doctor receives his statutory fee, and if a doctor engages to appear in court without a subpœna, he should arrange the matter of a fee beforehand (*vide infra*).

A doctor is a citizen with special privileges and responsibilities. One of these responsibilities is to give all the assistance that he can to a legal court of inquiry. He should attend such a court in this frame of mind. He is there to inform intelligent men of distinction on matters which, however much they may have "crammed" them for the purpose in hand, they do not completely understand. He should go well versed in his subject and with his ideas clearly orientated. He should go with a good humour which refuses to be ruffled by the exigencies of the proceedings, and he will rarely have cause to complain of the treatment which he receives.

In the Witness-Box

When in the witness-box the medical witness should speak clearly and slowly, remembering that the judge is usually taking notes in long-hand. Technical terms should be avoided, or if they are inevitable, their meaning must be carefully explained. He should address the president and officers of the court by their correct appellations. The president of a High Court or Court of Assize is addressed as "My Lord" (the legal contraction "M'Lud" is a privilege reserved for counsel). The president of a County Court is addressed as "Your Honour", and of a Police Court "Your Worship". Coroners, counsel on both sides, solicitors and other professional men are properly addressed as "Sir". Failure to address cross-examining counsel as "Sir" is a common fault with medical witnesses. It is an omission which is an exhibition of bad manners and creates an unfortunate impression with the court.

A witness may be subjected to the following examinations:

1. *Examination in Chief.*—This is undertaken by the counsel on the side which has called the witness. In a criminal case when it is undertaken by Counsel for the Crown, leading questions (or questions which suggest the answer) may not be put unless, by the witness's demeanour or the unsatisfactory nature of his answers, he is held to

APPENDIX IV

APPEARING IN COURT

A DOCTOR may be called upon to appear in court as a " witness giving professional evidence as to fact ", or as an " expert witness ". In the first instance he will be called upon to testify on such medical aspects of the case as the court may require, and he must be prepared to answer questions which might reasonably be expected to come within the province of a qualified doctor. In the second instance he is called upon to state his opinion upon the medical facts and his qualifications for expressing such an opinion may be probed in cross-examination. The experience of appearing in court is often an alarming one for the doctor. He is in unfamiliar surroundings and he is by training and inclination unused to the forensic battles that sometimes take place. No rules can be formulated to protect the medical witness from occasional discomfiture at the hands of cross-examining counsel or the president of the court, but these occasions are rare. The only reason for a doctor appearing in the witness-box is to further the cause of justice. No considerations of loyalty to a patient should persuade the doctor to give evidence on his behalf if that evidence entails an expression of opinion to which his conscience cannot subscribe. Defending counsel in a criminal case has a special privilege in this respect. He is there to put the case of his client as favourably as possible. He may fail to bring to light facts inimical to his case, although he is aware of them. The doctor is in no such relation to his patient : he is there to tell the truth, *the whole truth*, and nothing but the truth. The doctor should make the side who intends to call him aware of the nature of his testimony beforehand, and this is often done by means of the preliminary report. The responsibility for placing him in the witness-box then rests with them. A doctor is called to testify in court by arrangement with one of the parties, or he may be summoned to attend by " subpœna ". Failure to obey a " subpœna " renders the defaulter liable to indictment for contempt of court with very severe penalties. Presidents of courts are well aware that doctors are busy men, and my experience has been that they go to quite considerable lengths to take the medical evidence at such a time as will obviate the necessity of a doctor waiting about in court for long periods to give evidence.

referred to depends upon the president of the court. Notes made at the time of the examination are always acceptable, and if they are on the back of an envelope or are blood-stained, far from detracting from their value, this may be evidence of their *bona fides*.

As is well known, "hearsay" evidence is inadmissible, but there are two exceptions to this rule. A statement made by one of the parties to the action may be quoted, and the doctor may refer to the patient's symptoms, which can only have been related to him by the patient.

When questions are asked involving the divulgence of information confided to the doctor in secrecy, then the doctor may appeal to the president of the court if he considers that answering such a question would constitute a breach of confidence. Such a problem is liable to occur when the doctor has treated a patient for venereal disease. Although the policy of the Government is to pledge the doctor to absolute secrecy in these matters, so that patients may be encouraged to attend for treatment, the doctor is bound to answer questions on this subject if the president of the court insists that he should do so. The same principle applies in cases of tuberculosis where a similar attitude on the part of the doctor is enjoined by the Government.

A lawyer enjoys a unique privilege in this respect, in that he is not compelled to divulge in the witness-box information that a client has given him in confidence. Unethical though it may appear to be, a doctor enjoys no such privilege, although an appeal to the president of the court is always treated with sympathy, and in certain cases the doctor may be absolved from answering a question involving breach of confidence.

X-RAY PHOTOGRAPHS

The ownership of X-ray photographs has not been established in a court of law in this country It is assumed in medico-legal circles that ownership is vested in the radiologist. Certainly in the case of a hospital patient who has contributed no fee specifically for the purpose of X-ray examination, the X-ray photographs would be held by the court to belong to the hospital, to do with them as they liked. Similarly, where a surgeon has taken an X-ray photograph of a private patient in the course of his examination and has charged no fee specifically for this, his ownership of the films may be said to be absolute. Difficulty might arise where a radiologist has charged a fee for an X-ray examination. The implied contract is that the patient pays for the radiologist's opinion, not for his films. Certainly the patient has an ethical right to demand the use of the films should he require to show them to another doctor, and it is a right which no

be holding back the truth, in which case he may be stigmatised as a "hostile witness" and leading questions may be put.

2. *Cross-examination.*—Here opposing counsel seeks to discredit the testimony of the witness. He may bring out his qualifications or lack of them and considerable licence is given to counsel in interrogating a witness for this purpose. On the other hand the practice of discrediting a witness by impugning his personal integrity is not commonly resorted to nowadays. While serving to upset the confidence of the witness, these imputations carry less weight with the court than an exposure of conflicting or false evidence in the witness's previous testimony. For this reason the doctor should be perfectly clear in his mind on all aspects of the case before going into court. If he has kept in mind that his purpose is to help the court, then his testimony during the examination in chief will bear the closest scrutiny in cross-examination. He must preserve his good humour in the face of sarcasm and assumed hostility, and he must give the impression that he is as ready to help cross-examining counsel, as he was his own counsel, to arrive at the truth. If the truth as he sees it conflicts with the views expressed or suggested by cross-examining counsel, then this is a matter to be regretted.

If counsel asks the witness whether he is familiar with the literature on a certain subject, the witness should say truthfully, that he cannot be familiar with all the literature on that subject. Otherwise counsel may produce an obscure article, the importance of which is exaggerated and of the existence of which the witness may be quite unaware. Similarly, when counsel asks whether the witness knows "that great expert on Blankitis—Dr. Dash", the witness is fortunate if he can reply that he has never heard of him.

In criminal cases cross-examination conducted by counsel for the defence may include leading questions.

3. *Re-examination.*—This is undertaken by the counsel who called the witness and is devoted to clearing up doubtful points and also, if necessary and if possible, to re-establishing the credit of the witness in the eyes of the court.

4. *Questions by the President of the Court or by a Juror.*—No rules govern these questions, but they are usually confined to requests for the elaboration or explanation of some point which has arisen in the previous testimony and often, in the case of medical witnesses, to the elucidation of some semi-technical term the meaning of which may have been plain to the judge and to counsel with their classical education, but which may not have been clear to a juror. Notes may be taken by the witness into the box and the extent to which they may be

COUNTY COURT

1. *Witness giving Professional Evidence as to Fact.*

(a) A sum to cover reasonable travelling expenses.

(b) An allowance for the time expended in travelling and attendance. This may be between one and two guineas if the value of the suit is under £50 and between one and three guineas if the value of the suit is over £50.

2. *Expert Witnesses.*

(a) A sum to cover reasonable travelling expenses.

(b) A qualifying fee of one to three or one to five guineas each day, depending upon the value of the suit.

(Assessment by the Registrar to whom appeals and complaints may be addressed.)

The above are the scales of payment which in law the doctor is bound to receive if he attends a court on subpœna. If he is engaged by one party to appear as an "expert witness", he should make his own arrangements with the solicitors in regard to his fee before appearing and this agreement should be made in writing.

ROAD TRAFFIC ACT, 1934

A fee of 12*s.* 6*d.* per patient is payable by the user of the car (whoever may ultimately be held responsible for the accident) to the doctor who first attends the case. If summoned from a distance of over two miles he may in addition charge at the rate of 6*d.* a mile one way. The claim for fee must be made by word of mouth at the time, or by registered letter within seven days, and must be accompanied by a statement that the doctor was the first to attend the patient or patients. Alternatively, the account may be delivered by hand within this time.

radiologist would be likely to refuse. Whether the patient could or could not claim the right in a court of law is another matter. If he could do this, then the radiologist might be liable to damages if the films were mislaid or destroyed, a state of affairs unlikely to be upheld in a court of law.

Fees

Central Criminal Court, Quarter Sessions, Police Courts and Criminal Cases in Courts of Assize.

1. *Witness giving Professional Evidence as to Fact.*—In the town where the witness resides:

(a) One case only—not more than one and a half guineas a day.

(b) Two or more cases—not more than three guineas a day.

Elsewhere: not more than three guineas a day.

If the witness is detained away from his home for less than four hours, then this scale is halved.

2. *Expert Witness.*—Such allowances as the court may consider reasonable. (Assessed in the Courts of Assize by the Taxing Master to whom appeals and complaints may be addressed.)

3. *Travelling Allowances.*—The cheapest railway fare; or, if there is no railway, then the hire of a vehicle which must not exceed 1*s*. 6*d*. a mile each way.

No allowance is made for the employment of a *locum tenens* during the absence of the witness from his practice.

Coroner's Court

(a) If no post-mortem has been made by the doctor—one and a half guineas a day.

(b) For a post-mortem report without attendance at the inquest—two guineas.

(c) For making a post-mortem examination with report and attending the inquest—three guineas for the first day and one and a half for each subsequent day.

To qualify for these fees the post-mortem examination must have been made at the previous direction of the Coroner.

High Court, Court of Appeal and Civil Cases in Courts of Assize

In the town where the witness resides—a guinea a day. Elsewhere—two to three guineas a day plus travelling expenses not exceeding 1*s*. a mile one way.

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APPENDIX V

Approximate Equivalents of the Imperial and Metric Systems

Imperial	*Metric*
gr. $\frac{1}{100}$	0·5 mg.
gr. $\frac{1}{60}$	1 mg.
gr. $\frac{1}{32}$	2 mg
gr. $\frac{1}{16}$	4 mg.
gr. $\frac{1}{12}$	5 mg.
gr. $\frac{1}{6}$	10 mg.
gr. $\frac{1}{4}$	15 mg.
gr. $\frac{1}{3}$	20 mg.
gr. $\frac{1}{2}$	30 mg.
gr. 1	60 mg.
gr. 2	0·1 g.
gr. 3	0·2 g.
gr. 4	0·25 g.
gr. 5	0·3 g.
gr. 8	0·5 g.
gr. 10	0·6 g.
gr. 15	1 g.
gr. 20	1·3 g.
gr. 30	2 g.
gr. 60	4 g.
gr. 120	8 g.

Imperial	*Metric*
♏ 1	0·06 c.cm.
♏ 2	0·1 c.cm.
♏ 3	0·2 c.cm.
♏ 5	0·3 c.cm.
♏ 6	0·4 c.cm.
♏ 8	0·5 c.cm.
♏ 10	0·6 c.cm.
♏ 15	1 c.cm.
ʒ 1	4 c.cm.
ʒ 2	8 c.cm.
℥ 1	30 c.cm.
℥ 3	90 c.cm.
℥ 15	450 c.cm.
1 pint	0·5 litre
2 pints	1 litre
8 pints	4·5 litres
10 pints	5·5 litres

1 oz. *avoirdupois* 30 g.

Approximate Temperature Equivalents

Fahrenheit	*Centigrade*
98·4°	37°
100°	38°
105°	40·5°
110°	43·5°
115°	46°
118°	48°

$$C = \frac{(F - 32)5}{9}$$

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